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THE SUN DIAL AND ITS CONSTRUCTION.

By H. B. CURTIS.

Perhaps the easiest and most interesting application of astronomical knowledge for the amateur astronomer is the construction of a sun dial that will keep reasonably accurate time, that is to say, to the nearest minute. He will be putting himself in the rôle of the ancient pioneer astronomer to whom dialing was known with remarkable accuracy as early as the fourth century B.C.

The first mention of the sun dial in history is found in Isaiah 38:8: "Behold, I will bring again the shadow of the degrees, which is gone down in the sun dial of Ahaz, ten degrees backward." The date of this mention would be about 700 B.C., but we have no knowledge of the character of the dial or its construction. The earliest mention of which there is definite knowledge is one of a dial of the hemispherical type constructed by Berossus, a Chaldean astronomer. He lived about 300 B.C. This dial was used for centuries as is shown in the works of the Arabians as late as 900 A.D. Four dials of this construction have been found in modern times in Italy. It is recorded by Herodotus that the Greeks learned from the Babylonians the use of the gnomon. The Greeks who were great geometers constructed sun dials of considerable complexity which shows not only that they possessed extensive knowledge of astronomy and geometry but also that they were very ingenious.

There are several types of sun dials: (1) Horizontal, on a level plane; (2) Vertical, on a vertical plane facing one of the cardinal points; (3) Inclining, on a plane neither vertical nor horizontal; (4) Equinoxial, on a plane at right angles to the earth's axis. The design and a brief description of the construction of a sun dial of the horizontal (the most satisfactory) type will be given in this article.

Dialing is based on two fundamental astronomical facts, the diurnal and annual apparent motions of the sun. Due to these motions the sun appears somewhere in the sky every minute of the day time. It is the function of the sun dial, by means of a shadow cast by the gnomon on a plane marked off by lines, to enable us (after a certain correction has been made) to read off the time of day. The gnomon is essentially a sloping edge rising from the plane of the dial, placed so that its shadow will mark the time of day. For the horizontal type of dial the angle which this edge makes with the horizontal plane is equal to the latitude of the locality. The formula[1] on which this type of dial is

[1] Article by the writer: POPULAR ASTRONOMY, **17**, December, 1909.

based is:

$$\tan \beta = \csc \lambda \cdot \tan \phi.$$

In the article referred to in the footnote, the writer describes the design of a sun dial for any latitude. Some years later, in the summer of 1920, he designed a sun dial and, together with Mr. Clarence E. Baer, at that time head of the science department of the High School in New Castle, Pennsylvania, actually built one out of concrete. It tested out with great precision.

The design is briefly as shown in Figure 1. A drawing board, T-square, and drawing instruments were used with as great accuracy as possible.

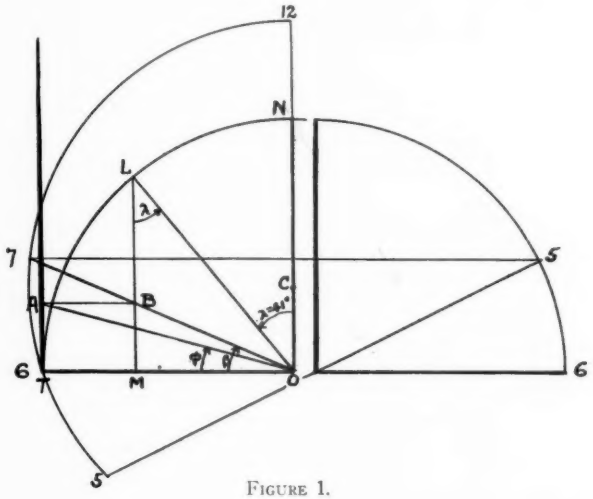


FIGURE 1.

The radius of the circle OT was taken to be about one foot long, the concrete slab, octagonal in shape, when done being 28 inches in diameter. The latitude, λ, was taken to be 41° (the latitude of New Castle, Pa.). Angle NOL was constructed equal to 41° and LM was dropped perpendicular to TO. To construct the hour line O7 for 7 o'clock A.M., OA was drawn making angle TOA (ϕ) equal to 15° (since 15° = 1 hour). Perpendicular TA was erected at T, tangent to the circle. AB was drawn parallel to TO meeting LM at B. Then OB was drawn which is the proper line for 7 o'clock A.M.

The formula is easily verified as follows: From the figure,

$$\tan \beta = MB/MO, \csc \lambda = OL/MO, \text{ and } \tan \phi = TA/TO.$$

It is seen at once that

$$MB/MO = OL/MO \times TA/TO$$

since by construction and geometry TO = OL and TA = MB. Simi-

larly the other hour lines were drawn. The P.M. lines were drawn by symmetry. Another circle with center about at C was drawn and the hour lines were extended to intersect it. The use of this circle improves the appearance of the dial. All the hour lines and a few of the half-hour lines were drawn by this accurate method of construction, but the quarter-hour and five-minute lines were interpolated by inspection with as good judgment as could be brought to bear.

A tracing was made of the drawing and several blueprints were taken. A blueprint was placed face down in a frame built for the concrete. The bottom of the gnomon mould was faced with a strip of galvanized iron one inch wide and about 18 inches long. This galvanized iron strip thus became the shadow edges of the gnomon. The concrete was thoroughly reinforced by wire netting. Mr. Baer displayed great skill and ingenuity in piecing together this frame including the gnomon mould. Brass plates of three different lengths were pounded edgewise into the wood through the blueprint on the hour, half hour, and quarter hour lines, the longest (about two inches) on the hour and the shortest (about half an inch) on the quarter hour lines. Brass tacks were pounded about an eighth of an inch into the wood at each of the 5 and 10 minute dots. Brass numbers which were purchased were placed at the ends of the proper hour lines 5, 6, 7, etc., face down and the letters A.M. and P.M., also purchased, were placed on the morning and afternoon sides of the dial respectively. The plate, on which were stenciled by means of metal letter dyes appropriate inscriptions, including the latitude and longitude of New Castle, Pennsylvania, was placed near the foot of the gnomon. The well-known sun dial quotation "Horas non numero nisi serenas" was also included here. Then the concrete, into which was mixed crushed stone of various colors, was poured. After setting for several days the frame was partially taken apart and the dial emerged intact, a gratifying sight indeed to behold. The blueprint was then torn out and destroyed. It was a simple matter to file down all the tack points and brass plate edges into little circular discs and straight lines even with the surface of the dial. The face of the dial was then polished off into a fine smooth surface. The dial was then ready to mount for testing. It weighed nearly a hundred pounds.

The problem of setting up the dial to be tested was very interesting. The evening preceding the day for testing was clear. The dial was brought to a temporary and roughly improvised foundation of small boards. It was leveled in two directions by the aid of a carpenter's spirit level and an electric flashlight, in a nearly north and south direction. The final orientation to the exact north and south line was done in the following manner. In the adjoining yard to the north, on a terrace, two uprights were placed in the ground the tops of which were whitened by a little flour to become somewhat more visible in the dark. The tops of these uprights were carefully lined up approximately with the North Star. To be even more accurate the position of true north

was approximated near Polaris and the two tops were put in line with this point as nearly as possible. Then "sight" was taken down these tops toward the gnomon of the dial. The final adjustment of the dial was then made, great care being taken so that the line of sight of the two upright tops should be a continuation of the galvanized slope of the gnomon, which should point to the true north point of the sky, at the same time taking scrupulous care also that the dial was level in the north-and-south and east-and-west directions. When the last touch of final adjustment was made, the rising sun of the following day was eagerly awaited.

A table of corrections[2] had been carefully prepared beforehand for New Castle. The longitude of New Castle (80° 20′ west) gives a constant correction (using 1° = 4 minutes) of about +21 minutes for standard time. This constant correction is easily obtained by subtracting the longitude of the standard time meridian of the locality from the longitude of the locality in degrees and multiplying by 4. This correction is "plus" or "minus" according as the locality is west or east of the standard meridian. Thus for New Castle, the longitude of the standard time meridian is 75° and the longitude of New Castle is 80° 20′. The numerical difference is therefore 5⅓°, which is "plus" because New Castle is west of the standard time meridian. This number times 4 gives 21⅓ as the number of minutes. So 21 minutes was used as the constant longitude correction. Similarly for any other locality.

This correction, due to longitude, must be further modified by a correction due to the "Equation of Time," which was also included in the table of corrections. When the equation of time is zero, as it is four times a year, the correction for New Castle is +21 minutes. When the equation of time is —1, the correction is +20 minutes and so on. So, for any locality, by use of a corresponding table for that locality, the correction for any day in the year can be obtained by adding algebraically the equation of time to the constant correction for longitude of that locality.

The day for testing the sun dial was gratifyingly clear, September 16. The correction to be applied on this date was 16 minutes. As the sun rose over the trees, with watch in hand set to correct time by a Western Union clock, the dial was eagerly studied. When the first ray of the sun broke thru the trees at 7:39 by the watch, the shadow of the gnomon on the dial was lying along the line of 7:23; just as it should have been! At each 15 minutes interval during the forenoon the reading of the dial was exactly correct as nearly as could be estimated. The following day the dial checked satisfactorily at each reading.

Later that same year the sun dial was more permanently mounted on a sewer pipe section at 1110 Delaware Ave., New Castle. There the sun dial has done good service for several years as a time piece, it being used on many an occasion to set the family clock.

[2] Similar to the one in POPULAR ASTRONOMY, **17**, 613.

THE TEACHING OF ASTRONOMY.
(Fourth Paper)

By HARRIET W. BIGELOW.

The philosophy of teaching science has been so well introduced in other articles of this series that I can do no better than speak principally of some of the practical applications which we have developed and adopted at Smith. With others we aim at something more than simply teaching Astronomy. Interest in collecting first hand data, reliance on one's own observations, judgment as to reasonableness of results, precision of thought and expression, the historical background are some of the values which students should find in our science.

About two hundred students each year elect the first course in Astronomy here to fulfill the requirement of a laboratory science and, as Professor Meyer has said, it is necessary to have regular observing and laboratory hours as in chemistry and physics. Our students meet in sections of twenty-five for evening and day time observing and indoor laboratory work as well as for the more formal class discussion. We have the advantage of a large laboratory room with flat observing roof built as an addition to the observatory itself by Miss Mary E. Byrd, first Director here and so well known as a pioneer in laboratory methods of teaching Astronomy. We can put fifty students at a time on the roof each with her own little hooded electric light and shelf space, and another fifty on the ground at similar lights around two sides of the building, each group of twenty-five under the supervision of an instructor. While we consider the naked eye the most important astronomical instrument for beginners at least, our equipment includes a dozen pairs of opera glasses and six small portable telescopes besides the 6-inch and 11-inch equatorials, the last being the least important. For measuring positions in the sky we have six of the universal instruments made by the Eastern Science Supply Company, which we place out of doors, when needed, on stands which we have had made of convenient height. These instruments were first made by a former concern who did not put in cross threads until we petitioned for them. In order that the students may look at the sun through the instrument and bring the cross threads upon the disk we furnish them with dark spectacles much darker than one can ordinarily find but which after some perseverance and insistence we can now obtain through a local optician. It is quite possible to measure altitudes and azimuths without as elaborate instruments as these. The gnomon is simple to make and to use and interesting historically. For some purposes the ideal instrument is a jointed ruler with the rivet just stiff enough to hold the observed angle until it can be measured on a protractor. This is the most direct

way that I know for leading students to visualize what is meant by angular distance in the sky, an idea which seems simple to us but which they often bungle.

For watching the sun's motions our observing list includes:

1. Measuring the altitude of the sun at noon.
2. Reading the altitude and azimuth several times during the day and plotting the resulting path.
3. Repeating the sun path observation three or four times during the autumn and spring.
4. Drawing a sketch of the western horizon and marking where the sun sets at various times during the year.
5. Recording, several times during the year, which zodiacal constellation is seen in the west in the early evening.

I am glad that Professor Boothroyd also mentioned that last one, always one of our favorites. One cannot forget that the sun travels east in its apparent yearly course after seeing it eat up one constellation after another. This topic combined with the first leads one to see how the path of the ecliptic, its obliquity, dates of the solstices and equinoxes, and length of the year could be found by the early watchers of the sky;—one of the places where, to use Professor Stetson's apt phrase, "modern youth can clamber over the trail which pioneers have blazed."

It is interesting to note how often topic 4 of those given above, simple as it is, is the one that first wakens a student's scientific impulse to gather data on her own initiative. Within a week one of my students has told me with enthusiasm that she has been making sketches of the sunrise point seen from her dormitory window and is greatly interested in watching the sun come north from the position seen before the Christmas vacation.

Determination of time, the difference between sun noon and standard noon, observations of sun spots, of the solar spectrum, I need not stop to describe; nor study of the moon's surface with naked eye, opera glasses and telescopes, change of phase, and diurnal paths. Our students all find the synodic period of the moon from drawings of the phase. With reasonable care in making the drawings they find twenty-nine or thirty days for the period from one lunation to the next and twenty-nine and a half days if they cover two or three lunations. For finding the sidereal period they estimate the distances and angles from two or three neighboring stars to the moon on several evenings in different lunations and obtain results that are remarkably near the true value.

Among our other evening topics are: hourly and daily change in the positions of constellations in the sky, positions of the equator and the ecliptic in reference to the horizon at different times of year, differences in length of sidereal and solar days, relation of the Milky Way to the constellations and to the horizon, appearance of the zodiacal light, length of twilight, changing distances of superior and of inferior

planets from the sun, motions of planets among the stars. Many students have never before experienced the rising and setting of stars. A planet's turning from retrograde to direct motion always comes to them as a surprise and they assume at first that they have made some mistake in their observations. On account of the college ten o'clock rule they do not catch a planet in its direct motion before it starts to retrograde.

A considerable list of very suggestive topics for sky work may be found in Miss Byrd's "Laboratory Manual in Astronomy." Her "First Observations in Astronomy," advertised in this journal, is also very helpful. We have also numerous indoor topics with globes, almanacs, diagrams illustrative of the text at all possible points. The Duncan celestial globes, made by the Eastern Science Supply Company, are in nearly constant use. But it is the direct work with the sky that we wish to emphasize whenever possible. After becoming thoroughly acquainted with constellations the students go on to the study of variable stars, doubles, nebulae and clusters, as seen with the naked eye, opera glass and small telescopes. In their study of variables they realize that they are dealing with real astronomers' Astronomy. And in the three most obvious naked-eye variables, Algol, Mira, and Delta Cephei, they meet three distinct classes. Only a little more experience is necessary to secure results from observations of Beta Lyrae. Mira is a most helpful link between naked-eye and telescopic variables and would, if there were time in the first course, give the necessary training for identifying telescopic fields. We offer a second observing course besides the usual courses in practical Astronomy but very few of our students find time for more than one year. We are therefore trying to open their eyes to the panorama of the heavens always there for the initiated to see and enjoy.

BEYOND THE STARS.

Beyond the stars, so wise men say,
Is night unpierced by light of day,—
    Unfathomed even by the beam
    Of those far-distant suns that seem
The outposts of the Milky Way.

And oft earth-weary I survey
The chasms there, as dreamers may,
    To catch, perchance, a farther gleam
        Beyond the stars.

Far from this sun-warmed bit of clay
My fancy comet-winged may stray,
    And if I do not learn the scheme
    By which Fate weaves my earthly dream,
I do not fear, though shadows play
        Beyond the stars.

—STERLING BUNCH.

Fort Worth, Texas.

THE NEXT PLANET BEYOND NEPTUNE.
Part II.

By WILLIAM H. PICKERING.

The Orbit of Planet *O*.

We have now received through the kindness of Professor Shapley a copy of the Greenwich observations of Saturn from 1916 to 1925, which through a misunderstanding of the data was not sent to me before. Table I can therefore now be substituted for the last portion of Table III in our previous paper.* The successive columns give the date, heliocentric longitude, deviation in longitude from theory according to Greenwich, deviation according to Washington, mean value, and average deviation. A study of these results brings out at once an interest-

TABLE I.

The Third Perturbation of Saturn by *O*, Continued.

Date	H. L.	Green.	Wash.	Mean	A. D.
1915.0	89°	+1″.20	—0″.71	+0″.24	±0″.96
1916.0	103	—0.98	—0.83	—0.90	±0.08
1917.1	117	—1.28	—0.86	—1.07	±0.21
1918.1	131	—1.18	—1.32	—1.25	±0.07
1919.1	144	—2.01	—1.07	—1.54	±0.47
1920.2	158	—2.70	—1.26	—1.98	±0.72
1921.2	171	—1.62	—1.62	—1.62	0.00
1922.2	184	—2.12	—1.63	—1.88	±0.24
1923.3	197	—2.43	....	—2.43	....
1924.3	209	—1.12	....	—1.12	....
1925.3	221	—2.50	....	—2.50	....

ing fact. In our last paper we noted that, according to Washington, between the years 1910 and 1912 a remarkable fall of 2″.18 had occurred. We now find that between 1915 and 1916 according to Greenwich there occurred a fall of exactly the same amount. In both cases in the mean time an instrumental change in equipment had been made. In Table I therefore I have not added the constant correction of 1″.50 to the Washington results that was added in the later portion of the former Table III. This appeared to be necessary in the former case in order to render the two series of observations comparable, and also comparable to the earlier observations going back to the year 1829. Since 1915 the two series are comparable as they stand, and presumably need no correction, but since they now indicate that the planet lies about 1″.5 behind its position as given by Hill's theory, it is evident, if the early observations are correct, that the theory requires some adjustment.

The curved line which represents the deviations in longitude of Saturn has a very curious irregular form. It was materially straight-

*Popular Astronomy, March, 1928, p. 143.

ened by the sinusoid used in Figure 8 of my former paper prior to the year 1870, but since then the reverse effect has been produced, and the irregularities are exaggerated. These irregularities have nothing to do with the perturbations caused by planet *O*, which are much smaller, and extend each through only about 40° of longitude. It should be remembered that except for confirming the perturbations of Uranus and Neptune, the perturbations of Saturn are of consequence only for determining the eccentricity of the orbit of *O*. The present position of *O* in the sky, as was shown in our previous paper was determined by the perturbations of the two outer planets, and is otherwise but little affected by any reasonable orbit that we may adopt. The character of the orbit, however, depends upon Saturn, and is certainly of interest, especially should *O* prove, as seems probable, to be a companion planet to Neptune.

A more detailed study of the three perturbations due to Saturn has therefore been made. A comparison of the fourth and fifth columns of Table I shows us that while the former indicates a drop of 0″.46 after the year 1917, which in our last paper we attributed to the third perturbation by *O*, the recent Greenwich data, just received, reduce this drop to only 0″.18. At first this seems rather a setback to the belief in the elliptical orbit already proposed, but if we refer to Tables IV and V of the previous paper, we shall see that the last columns of both tables indicate a deviation of a whole year for this third perturbation from the computed orbit. The perturbation should, we found, have occurred in 1918. So large a deviation was felt at the time to be rather a liability than an asset to the theory. The first perturbation of Saturn, that of 1850, was well marked, 0″.8, and was as we then stated perhaps rather too much so. The distance between Saturn and *O* as shown by the third and fourth columns of Table V was 22.8 units. In the case of the second perturbation this distance was increased to 27.1 units. Squaring their ratio the second perturbation should be 71 per cent of the first, or 0″.57. We found it to be 0″.35. Similarly the third should be 82 per cent of the first, or 0″.66. We find by the fifth column of Table I that from the proper maximum in 1918 the drop the first year is 0″.29, followed the next year by a further drop of 0″.44. If the reading in 1919 is too high, part of this second figure should be included with it.

While the dates of these perturbations as we see by Table V are now in excellent agreement with the requirements of the elliptical orbit, the irregularities of the curve associated with Saturn are relatively so large, that we feel some further corroboration of the orbit is desirable. This we can obtain by a comparison of the perturbation of Neptune by *O* in Figure 5, with that of Uranus by *O* in Figure 6. The difficulty with this comparison, however, is two-fold. If we try to compare the rise to the maximum, the curve for Neptune is excellent, but that for Uranus prior to 1836, longitude 330°, is of very doubtful character, as is shown by the irregular distribution of the observations. On the other hand if we attempt to compare the drop after the maximum, the curve

for Uranus is not so bad, but that for Neptune is still incomplete. Perhaps the former comparison is the safer of the two, since we are at least fairly sure of the amount of the deviation of Neptune. An examination of Figure 5 indicates that had it been possible to secure an observation of Neptune in 1833, in longitude 300°, a total rise to the maximum of 3″.9 would have been comparable to the rise of 88″ in Figure 3. Consequently the first figure in the ninth column of Table VI should be changed from 2″.7 to 3″.9, and the corresponding ratio in the tenth column from 33 to 23. This change will increase the mass of planet *O* from 0.5 to 0.75 of that of the Earth, and its magnitude in 1928 from 12.1 to 11.8. The rise of the perturbation of Uranus in Figure 6, as measured between 333° and 360° we notice is at least as much as 1″.6, and may be 2″.1. Taking it at the former value, let *D* equal the distance of *O* from Neptune in longitude 95°, given by subtraction in the fourth line of Table V, as 5.3 units. The mass of Neptune, *M*, we will take as 17.2, that of Uranus, *m*, as 14.7, and that of *O*, *a*, as 0.75. Then *d*, the distance of *O* from Uranus in longitude 354°, should equal

$$D\sqrt{\frac{3.9\,(m+a)}{1.6\,(M+a)}} = 7.7 \text{ units.}$$

This added to 20.1, the distance of Uranus from the Sun, gives for the distance of *O* from the Sun 27.8 units, compared with 30.3, the distance as given in the first line of Table V. If instead of 1″.6 we believe the larger value 2″.1 for Uranus is more correct, we shall have $d = 6.7$ units. This will place *O* still nearer the Sun. This method of computing is by no means as accurate for orbital purposes as that of the planetary displacements employed in the previous paper. It indicates, however, very clearly that the orbit of *O* sometimes does lie within that of Neptune (see Figure 10, p. 161). We see no reason to change the elements already adopted for the orbit. In our next paper we shall present the evidence so far secured for the existence of a large planet located far beyond Neptune, and near longitude 350°.

PRIVATE OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I., FEBRUARY 20, 1928.

NOTE.

Since writing the above a letter has been received from Professor Shapley, stating that three photographs taken on the evenings of January 20, 21, and 22, had been examined for planet *O*, but that it had not been found. The region photographed was in $\alpha\ 9^h\ 00^m$, $\delta + 16°.5$. This is very close to the position in the ephemeris given in the previous paper for these dates, and would imply that the ephemeris was in error by at least 2°. Although regrettable, this does not greatly surprise me. While Leverrier's estimate of the location of the then unknown planet Neptune was in error by only 0°.9, the error of Adams was 2°.5. The declination given in my ephemeris was necessarily only an estimate. The right ascension was a computation which I believe to be correct, but

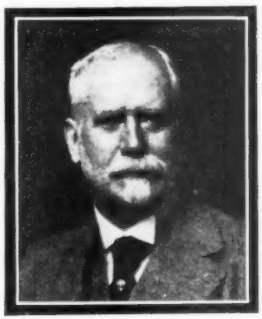
since, owing to the very small mass of the planet, the perturbations produced by it were small, in proportion to the accidental errors in the observations made of Neptune in 1904, and of Uranus in 1841, it is possible that the dates which I selected were in error by a year or two. An error of one year in the location of the maximum for Neptune would make a difference of a little over two degrees in the location of planet *O*. This information is given here for the benefit of any other astronomers who may be sufficiently interested to look for the planet. It may be mentioned incidentally that since *O* will reach its stationary point about April 20, photographs made now to detect its motion should be taken several nights apart.

FEBRUARY 24, 1928.

CHARLES CARTLIDGE GODFREY.

By GEORGE WALDO, Jr.

Dr. Charles Cartlidge Godfrey, president of the American Association of Variable Star Observers, physician, surgeon, man of affairs, and ardent amateur of many sciences, died on August 31, 1927, at Bridgeport, Connecticut, at the age of 72. To his home community this meant the passing of a beloved citizen, a leader of civic affairs, and an inspiration to young and old by the example of his useful and busy life. To the world of science it meant the loss of a disciple whose character was moulded by that keen intellectual curiosity which impels its possessor to search ceaselessly for the secrets of Nature, finding in that pursuit a lifelong happiness transcending the barriers of time and place.



CHARLES CARTLIDGE GODFREY.

To the inner circle of his friends the sense of personal bereavement in his death was tempered by their recognition of eternal qualities in

this soldier of science who faced death as he faced life, with smiling courage and wise philosophy.

Dr. Godfrey was born in Saybrook, Connecticut, the son of the Rev. and Mrs. Jonathan Godfrey, his father being an Episcopal clergyman. He was a lineal descendant of Christopher Godfrey who settled at Greens Farms, Connecticut, in 1685. Shortly after the Civil War the family moved to Greenfield Hill, near the ancestral Godfrey home, a beautiful section of the old and historic town of Fairfield. Here Dr. Godfrey spent his boyhood days and received his early schooling. To those who know this section, with its beautiful landscape of rolling hills and glowing valleys, of meadow brooks and smiling fields, of sunny seashore and cool, mysterious woods, no further explanation is needed of that love of Nature which was the outstanding characteristic of Dr. Godfrey's life. Not under the schoolhouse roof but here beneath the open sky which in later life he was destined to explore so eagerly with eye and mind, his real education was assimilated.

This active boyhood in the open left an indelible impress on his life. Nothing in Nature failed to interest him. The boy who picked wild flowers became the botanist who went beyond the outward beauties of form to the inner beauties of orderly development and who ranged the whole of Eastern North America, from the Carolinas to Labrador, in search of varieties for the botanical catalogues or new specimens for his herbarium of more than 15,000 plants, mounted and catalogued with endless skill and patience. The youth, who took long tramps afield and sometimes looked to the stars to guide his steps at night, learned to follow those stars as far as the paths of research could take him, so that to the day of his death he never turned his eyes or his mind to the sky without that same thrill of fascination and wonder as in the beginning.

In school Dr. Godfrey's natural bent was toward science. He matriculated at Sheffield Scientific school of Yale University in 1877, specializing in chemistry and receiving the degree of Bachelor of Philosophy. Choosing a medical career as his life work he attended the College of Physicians and Surgeons at Columbia University and later Dartmouth medical school, from which he graduated with the degree of Doctor of Medicine in 1883. He chose Bridgeport for his practice and became associated with the late Dr. Robert Hubbard, perhaps the most famous physician of his day in Connecticut, a man whose memory is still a tradition among the fraternity. Undoubtedly it was this association which had much to do with coloring Dr. Godfrey's philosophy of life and moulding his firm, cheerful, and courageous character.

Dr. Godfrey was married April 30, 1885, to Caroline St. Leon Sumner, a daughter of Col. Samuel Sumner and Georgianna (Davis) Sumner of Boston. Mrs. Godfrey's death on February 13, 1924, terminated an ideally serene and happy married life. A daughter, Miss Carrie Lucille Godfrey, survives.

In his chosen profession of physician and surgeon, Dr. Godfrey attained every honor that his community could bestow. He was the personal physician of P. T. Barnum, the showman, and of many other eminent men. He served as surgeon of the Fourth regiment, Connecticut National Guard, and in 1903 and 1904 was surgeon general of the state. He was connected with both the Bridgeport and St. Vincent's hospitals since their founding, having been surgeon in chief of the former and president, director, and member of the executive committee of the latter. He was a member of the Association of Military Surgeons, the New York Academy of Medicine, and a fellow of the American College of Surgeons. His private practice was so extensive that in his later life he had to set limits upon it to conserve his time and physical energy. At various times he headed his city, county, and state medical societies and played to the fullest the rôle of physician, healer, and friend, acting as guide and counsellor to the younger members of his own profession. In a word his professional career comprised an endless round of activities and achievements covering more than a generation in time and representing alone an accomplishment which any man might proudly regard as a life work. Yet the professional side of Dr. Godfrey's life was only one of many phases in a bewildering record of physical and intellectual activity.

Thus Dr. Godfrey's contributions to the social and political life of his community were almost as numerous as his professional achievements. He was one of the founders of the Bridgeport Library and one of the organizers of the city's modern school system. His early researches into the relationship between typhoid fever and water supply led him to become interested in the organizing of a proper system for Bridgeport; he was one of the founders of the Bridgeport Hydraulic company and a director of that institution, helping to shape the policies of that company and feeling rewarded in seeing his city's typhoid rate sink to a position among the three lowest in the nation, thanks to the purity of its water supply.

When the first telephone exchange in America was opened in New Haven, Connecticut, in the 1870's, Dr. Godfrey at once became interested in this newest means of communication. He took up the study of electricity with enthusiasm, organized a company to extend the line to Bridgeport and Stamford, and possessed the first private telephone in his community. The interest thus established was never abandoned. When Marconi announced the first principles of radio communication, Dr. Godfrey at once plunged into that subject, studied the theory of radio, built his own instruments, and mastered the code. Keeping fully abreast of every development of this art, he improved his own equipment, built his own sets and contributed to the proceedings of the Institute of Radio Engineers of which he was a member.

Mention has already been made of Dr. Godfrey's lifelong interest in botany and his possession of an extensive herbarium. His enthusiasm

for this subject led him to make two expeditions to northern Canada and he added much to the knowledge of the flora of this region. A violet which he discovered is named Godfriensis in his honor in the American botanical catalogue. He was a member of the Torrey Botanical club and the Connecticut Botanical society. He was also a member of the American Association for the Advancement of Science, and many clubs and fraternities in and about Bridgeport. His astronomical associations included the American Astronomical Society and the American Association of Variable Star Observers. One of his last public functions was to preside at the spring meeting of the latter organization, held at Yale in April, 1927.

At various times Dr. Godfrey represented his community in the city council, on the school board, or in the state legislature. He helped to organize the Bridgeport Scientific and Historical Society, was its president for several years and a director at the time of his death. During the World War Governor Holcomb of Connecticut appointed him a member of the State Council of Defence and he headed the medical section of that body.

Historians found in Dr. Godfrey an ardent fellow spirit, and with characteristic energy and enthusiasm he devoted himself to a speciality in this science, studying and collecting Napoleona, until he built up one of the finest private collections extant of the autographs pertaining not only to the great emperor himself but to his family and his associates.

This sketch of Dr. Godfrey's activities pretends to be only a bare outline, of which it is impossible here to fill in the details. In giving it, the account of his most beloved avocation has been reserved for the last. Whatever may be said here in tribute to Dr. Charles C. Godfrey is intended primarily for the eyes of those who knew him personally or by reputation and consociation as a brilliant amateur in the oldest and noblest of the sciences.

It is impossible to name the exact date when Dr. Godfrey's interest in astronomy began but it is easy to conjecture that it commenced when he first opened his eyes and blinked at the world. As a boy he familiarized himself with the constellations. As a youth at college he elected astronomy among his courses. The same act of will which launched him on his professional career included a determination to pursue the study of the stars as one of the major avocations of his life. From this determination his spirit never flagged. In his long lifetime this bubbling well-spring of enthusiasm never diminished. The boy who learned to identify the Great Dipper as it cleared the trees of his native Greenfield Hill, and to follow its pointers to the Pole Star, was no younger in spirit than the man of 72 who, on his deathbed in Bridgeport hospital, received from the hands of a friend a copy of the latest book embodying the theories of stellar evolution and devoured it page by page with keenest enjoyment. The fingers which faltered in their effort to turn the leaves were shamed by the spirit which lamented that there

was no more.

It may be assumed that the clergyman's son who had put himself through college partly through his father's assistance, partly through his own efforts, and who began his professional career in 1883 was not overburdened with wealth after his long apprenticeship. He had already learned what he could of astronomy from books and he determined to supplement and extend this with astronomy from the sky. He wanted a telescope very badly but the cost of the instrument in itself represented an astronomical sum to one of his limited resources. If he would have a telescope then, he must make one. Considering that a stout-hearted amateur might falter at this prospect today, what was the condition more than 40 years ago, when books upon the subject were comparatively rare and direct instruction in the grinding and figuring of lenses and mirrors almost wholly lacking?

None the less Dr. Godfrey bent himself to the task. He combed every printed source of information in America and England. Determining that a reflector would represent the type of instrument most suitable to his limited resources as an instrument maker, he taught himself the theories of the parabolic curvature and set himself to work out the practical application of grinding, polishing and figuring astronomical mirrors.

Here again he was initiating a pursuit which he was never wholly to abandon, for eventually he made mirror after mirror, and from a neophyte in the subject he developed into a recognized authority whose advice was courted by others all over the world. He constructed mirrors ranging from four inches to twelve inches in diameter, of various focal lengths, with the mountings to hold them. He attained such great skill in the final polishing and figuring that his mirrors answered the Foucault test to perfection.

Each success led him on to others and to the day of his death he was planning further mirrors of special type. In his later years he carried on a very extensive correspondence, giving advice and instruction to others who were attempting the same kind of task. The cellar of his home in Stratford, Connecticut, a suburb of Bridgeport where he spent his last years, was fitted up with complete equipment for grinding, polishing, and testing his mirrors, as well as a lathe and other machinery for making the mountings. Those who have used Dr. Godfrey's mirrors attest to the perfection of figure, shown by the crisp, sharp stellar images and the splendid planetary detail.

It was genuinely a milestone in Dr. Godfrey's personal life as well as in his avocation as an amateur astronomer when a happy chance brought him into the American Association of Variable Star Observers in 1919. Here in this association devoted to the science which he loved, he found the brotherhood of spirit which made him feel instantly at home. In turn he brought to it qualities of leadership, of ability, and of inspiration and enthusiasm which were instantly recognized and embraced.

He was made a member of the Council, and was elected Vice President and eventually President, an office which he held at the time of his death.

Only those who knew Dr. Godfrey intimately can realize how much this new association meant to him, in its personal contacts, its warm friendships and its fellowship in science. It was a source of unfailing joy and enthusiasm. No pressure of affairs, civic or professional, could wield priority over its claims. He gave in fullest measure and received in turn that satisfaction of soul as well as of mind which science affords to the initiate. When his final illness came upon him and he was confined for the first time in his life as a patient in that hospital where his presiding genius had held sway so long, and where his surgeon's skill had brought relief to countless others, his visitors had to be limited for the welfare of the patient. But one order went forth from the start, and was obeyed to the end. No matter at what hour any of his astronomical friends chanced to call, they were to be admitted at once. It is pleasant to recall that many did come, that they saw the face that beamed with pleasure, the smile that never failed and the eye that always sparkled. And when they left, it was with the impression of having been in the presence of one whose spirit was deathless.

Dr. Godfrey's funeral was held in St. John's Episcopal church, Bridgeport, and he was buried in Mountain Grove cemetery in that city. Included in the beautiful floral tributes which filled the church was a star of yellow roses from his associates in the A.A.V.S.O., with the following verse:

"Feet firm on earth,
Warm heart in place,
Wit ever on his lips,
Eyes on the roving stars."

THE CAMBRIDGE ASTRONOMICAL SOCIETY OF 1854.

By SOLON I. BAILEY.

A local astronomical society was founded at Cambridge, Massachusetts, in 1854. The records of the Society have recently been found among the old books and papers preserved at the Harvard Observatory. It was, perhaps, the first astronomical society in the United States, formed for serious scientific studies by its members; and, indeed, in some aspects it has had no counterpart among the astronomical societies formed since that time.

It should be stated, however, that an association called the Cincinnati Astronomical Society had been formed in 1842 by General O. M. Mitchel, one of the most enthusiastic astronomers of his day. The name of the society appears to be somewhat inconsistent, since it was com-

posed of individuals pledged to financial support of Mitchel's plan for a new observatory rather than to astronomical pursuits. It is of interest, also, to note that an astronomical journal called "The Sidereal Messenger" was started by Mitchel in 1846. It was a pioneer effort and was obliged to suspend in 1848. A new "Sidereal Messenger" was begun in 1882, by Professor W. W. Payne at Northfield, Minnesota, which, under different names, has continued without interruption until the present. It is now called POPULAR ASTRONOMY.

The leading spirit in the formation of the Cambridge society appears to have been Benjamin Peirce, then Perkins Professor of Astronomy and Mathematics at Harvard University. At the time he was about forty-five years of age and at the height of his reputation and powers. Peirce thought that the society should be formed as the local branch of a national astronomical society, the foundation of which he foresaw. The name selected, therefore, was The Cambridge Branch of the American Astronomical Society.

The first meeting was held on January 24, 1854, when the general plans were formulated. The constitution of the society, adopted at the second meeting, contained the following unusual section: "Membership of this society shall have a period of four years (subject to the limitations hereinafter named) and shall be held by no one for a longer period without re-election. Those now constituting the society shall be divided into four classes of nearly equal number whose terms of membership shall expire with 1854-55-56-57 respectively and in the same order with succeeding years. It must be decided by lot to which of these classes each of the present members shall belong." From this decision by lot it happened that Messrs. Hill, Runkle, and Oliver would cease to be members at the end of the first year, Peirce and Winlock at the end of the second year, Eastwood, Kerr, and Wright, at the end of the third year, and Bond and Safford, at the end of the fourth year, unless previously re-elected. A few other members joined later, and were assigned to different classes. Benjamin Peirce was chosen President, John D. Runkle, corresponding secretary, and Joseph Winlock, recording secretary. The president and secretaries constituted a publishing committee. The members of the society voted, "And we consider it our duty to endeavor to promote its prosperity by attending its meetings, taking part in its discussions, and by communicating to it any original investigations which we may make in Astronomy, Geodesy, and Mathematics." Plans were suggested for the election of Honorary Associates, "to consist of gentlemen not mathematicians," but this revolutionary proposal met much opposition and was indefinitely postponed.

Some idea of the character of the society may be had from the titles of the first half dozen papers, given in the order in which they were presented: Some Equations for determining the Errors of an Equatorial Instrument, Joseph Winlock; The Transformation of Coördinates, Thomas Hill; The Theory of Attraction, Benjamin Peirce; Interpreta-

tion, Mr. Hill; The Practical Indeterminateness of the Equations for the Simultaneous Determination of the Errors of the Transit Instrument, George P. Bond; Chaslesian Shells, Mr. Peirce.

Original papers, however, did not altogether fill the scientific program of the Society. A list of new scientific books and papers was assigned to each member, whose duty it was to prepare reviews and criticisms for the benefit of the other members. As an example of the obligations involved, it will be sufficient to state that, at the second meeting held on January 31, to George P. Bond were assigned eleven such publications for review, covering such topics as parallaxes, the mass of Saturn, physical observations of Saturn, Solar Eclipse, chronometers and clocks. Similar assignments were made to the other members.

It may be doubted whether any group containing a larger percentage of able men has ever been gathered into a society, either local or general. They deserve individual mention: Benjamin Peirce, 1809-1880, Professor of Astronomy and Mathematics at Harvard University, the ablest American mathematical astronomer of his day; John D. Runkle, 1822-1902, for many years Professor of Mathematics at the Massachusetts Institute of Technology; Joseph Winlock, 1826-1875, Director of the Harvard Observatory from 1866 to 1875; Benjamin A. Gould, 1824-1896, a famous American astronomer, founder of the *Astronomical Journal*, and first Director of the Córdoba Observatory; George P. Bond, 1825-1865, Director of the Harvard Observatory from 1859 to 1865; Simon Newcomb, 1835-1909, for many years America's most widely known astronomer; Christian H. F. Peters, 1813-1890, Professor of Mathematics at Hamilton College, and Director of the Litchfield Observatory from 1858 to 1890; Truman H. Safford, 1836-1901, Assistant at the Harvard Observatory from 1854 to 1865, Field Professor of Astronomy at Williams College, 1876-1901, in his younger years a mathematical prodigy; Thomas Hill, 1818-1891, an accomplished mathematician, clergyman, and writer, President of Harvard University from 1862 to 1868; also Messrs. Eastwood, Kerr, Oliver, and Wright.

With such a membership, a prosperous and permanent future might have been predicted. Such was not the outcome, however. So far as can be judged by the records, the activity was intense for a few months, after which interest appeared to lag. The last meeting of the society in 1854 was held on October 24. No other meeting is recorded until December, 1857, when a final session took place. The brief minutes of this last meeting furnish no suggestion of an approaching dissolution, and one can only conjecture as to the causes.

No doubt changes in residence of members may have caused a few loses.

The peculiar rule in regard to the brief duration of membership with the necessity of re-election may well have had some effect.

The intensity of the early programs may perhaps have put too heavy a burden on men already fully occupied with regular duties.

It seems probable that some friction may have developed, owing to the dominating, not to say, aggressive, characteristics of a few of the members.

Also, it is not clearly apparent, that an urgent need existed at that time for such a society. The American Academy of Arts and Sciences, in Boston, and other general societies in the country, offered facilities for the presentation of papers on Mathematics, Astronomy, and Geodesy, and for their publication.

All these causes, and perhaps others, may have combined to bring about the apparently untimely end of this Cambridge Society.

JANUARY, 1928.

THIRTY-NINTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 143.)

ABSTRACTS OF PAPERS

RESULTS OF OBSERVATIONS OF THE MOON IN 1926.

BY E. W. BROWN.

This is a summary of the work done with the assistance of members of the A.A.V.S.O. The mean value of the observed minus tabular error of the year, from the occultations, is $7''.3 \pm 0''.08$. These, with the large number of occultations reduced by Innes in 1923-6, were shown to give a "limb effect." This explains why a constant error of latitude was obtained, which differed from that deduced from the meridian observations. The results will appear in *The Astronomical Journal*.

CHANGES IN THE SPECTRA OF VARIABLE STARS OF LONG PERIOD.

BY ANNIE J. CANNON.

So far as known, the first photographic spectrum of a variable star of long period, that of Mira, was obtained with the 8-inch Bache telescope at the Harvard Observatory on December 11, 1885. This photograph, which is still in good condition, showed the most significant feature of the spectrum to be the presence of bright hydrogen lines. Five days later, the spectrum of the star then called Nova Orionis was secured. Its similarity to the spectrum of Mira placed it in the variable class, and it was lettered U Orionis.

The photography of the spectra of these variables, about 130 of which were known in 1885, thus became one of the first investigations of the Henry Draper Memorial. In the Draper system of classification the banded spectra had been lettered M, with the three sub-divisions Ma,

Mb, and Mc. The designation Md was assigned to any kind of an M spectrum, in which there were bright hydrogen lines.

As early as 1898, Mrs. Fleming proposed the subdivision of the Md spectra into ten classes, depending on the strength of the bands, and the intensity of the hydrogen lines.

Renewed interest in these spectra has arisen at Harvard because of the active preparation by L. Campbell of a catalogue of variable stars of long period, taken, in general, from a draft of a catalogue of all variable stars prepared by S. D. Townley. The new catalogue of these stars will contain about 1600 variables, for which it is proposed to give the spectrum whenever possible.

About 400 of these spectra are known to be of Class M, with bright hydrogen lines, now called Me, which have been subdivided into Class Me0 to Me9, mainly by means of the work of Adams, Merrill, and Joy, at Mt. Wilson.

The changes in these spectra, visible on the Harvard photographs, occur in various particulars, such as the distribution of light in the continuous spectrum, the bright hydrogen lines, other bright lines, and the general class of spectrum.

In spectra of Classes M1 to M4, Hγ is usually the strongest bright line, and Hδ brightens near maximum.

In classes M5 to M8, Hδ is always the strongest bright line except near maximum, when Hγ may equal or even exceed it.

For some of the brighter stars, there are sufficient photographs to throw much light on the time of appearance of the low-temperature emission lines, such as 4571 of magnesium, 4307, 4202 of iron, and 4030 of manganese. This may be important in connection with the temperature of the stars.

As Merrill has shown, the class of spectrum at maximum is in general a function of the period, and in all cases so far examined, when the star becomes fainter, the spectrum is of a later subdivision of Class M.

THE TOTAL SOLAR ECLIPSE OF 1932 AUGUST 31.

By L. J. Comrie.

A rigorous calculation has been made in advance of the usual *Nautical Almanac* prediction. Oppolzer's track, which crosses the northern part of Maine, is much too far north. The track given by Seagrave in Popular Astronomy for November, 1925, is considerably in error, but as the error is principally in the time coördinate the plotted track coincides fairly closely with the true track.

Newcomb's *Tables of the Sun* have been used, with a correction of +1".5 to the longitude, and Brown's *Tables of the Moon*, with a correction of +7".0 in mean longitude, but no latitude correction.

Roughly speaking the eclipse occurs at 3:30 P.M. local time, lasts 100

seconds, the sun being 30° high and the track 100 miles wide. The central line runs from Pierreville, Quebec, to Biddeford, Maine. The southern limit of totality runs from Montreal to Salem, Massachusetts, and the northern from St. Jean des Chaillons, Quebec, to Richmond, Maine. The central line passes over the White Mountains, which will probably provide some good observing sites.

CENTRAL LINE OF TOTALITY.

G.M.T. h m	Longitude ° ′	Latitude ° ′	Duration s	Altitude °
20 22	73 29.3	46 48.2	101.9	32
24	72 48.6	46 0.6	101.1	31
26	72 7.0	45 13.1	100.3	31
28	71 24.3	44 25.7	99.5	30
30	70 40.2	43 38.4	98.5	30
32	69 54.7	42 51.0	97.5	29

SUNSPOTS AND ANIMALS.

BY RALPH E. DE LURY.

In numerous instances vegetation has been found to vary with the eleven-year solar period. It is to be expected that animal life also reflects the same periodicity, and in some cases this effect has apparently been found, as for instance in the dates of bird arrivals (Montdidier, France, 1784-1869). Long records are unfortunately rare. However, the records of the Hudson's Bay Company's furs for the past century are valuable. Charts of these records are given in Hewitt's book, *The Conservation of the Wild Life of Canada*. A comparison of the "rabbit" chart with the sunspot chart at once reveals the fact that maxima of the former occur about one year before minima of the latter, and maxima of the spots during the longer minima of the rabbits. The 11.5-year mean numbers of sunspots show remarkable agreement with the smoothed $[(a+2b+c)/4]$ mean numbers of rabbit pelts, for the years 1846-1909, as follows:

Years after Min. of spots	—1	0	1	2	3	4	5	6	7	8	9	10	11
Sunspot Numbers	..	5	16	44	77	86	83	69	50	37	23	14	6
Rabbit Pelts, Thousands	81	71	50	35	27	27	26	29	35	50	67	76	..

Other fur-bearers, as pointed out by Hewitt, show dependence on the variations in the numbers of their prey, the rabbit.

Records of living things, which integrate the various meteorological changes, may reveal in such ways as growth, health, number, and migration, the solar variations in a way not so readily apparent from the usual meteorological records.

NOTE ON THE ORIGIN OF THE NEBULAR SPECTRUM.

By C. T. Elvey.

This paper deals with Bowen's hypothesis that the nebular spectrum is the result of transitions from metastable states. It suggests the possibility of getting important data from the novae as to the physical conditions required for the production of the nebular lines. With certain assumptions an upper limit for the density of the expanding shell of gas at the time of the appearance of the nebular lines is calculated. This is illustrated with a calculation for Nova Aquilae 3. The paper is printed in full in Popular Astronomy, XXXVI, 7.

THE TOTAL SOLAR ECLIPSE OF AUGUST, 1932.

By Caroline E. Furness.

The computation of the eclipse made under the direction of Mr. Comrie was received in advance of the meeting. The U. S. Weather Bureau of New England has not enough stations to secure the needed weather statistics over the belt of totality. Professor Todd organized volunteer observers in 1925, and later placed his material in the hands of Professor Slocum, who will collect and publish the data.

The path of totality passes over some of the most popular outing regions of New England at the height of the season. Places for observation in these mountainous and unsettled regions must be carefully sought, and early coöperation with various outing organizations is suggested.

ON THE STARS WHOSE SPECTRA HAVE BRIGHT LINES.

By B. P. Gerasimovič.

As a statistical phenomenon the stars whose spectra show bright lines are confined to four chief continuous sequences:

1) *Variable Stars,* a sequence which embodies Mira variables (Md and S) and super-giant semi-regular variables, chiefly of RV Tauri type (K, G, and F).

2) *Super-Giant* F-B sequence, which, beginning with such stars as Y Carinae, extends through the A-type super-giants (like α Cygni) continuously into type B. Emission lines in the spectra of Be stars are hazy and broad. They are the lines of H, Fe, Fe+, etc., and occasionally He. The metallic emission lines in this sequence require less excitation energy than the characteristic absorption lines like C+, Si+++, etc., and are absent in the absorption spectra of normal B stars. This shows that metallic emission lines originate at lower levels (than the characteristic absorption lines), where they are nearer to the

surface of minimum ionization. These stars are abnormally luminous and cool. Low temperature is here one of the high-luminosity phenomena, but it cannot be explained so simply as in the case of later giants. It can be shown that the anomaly is not caused by low surface gravity and may be interpreted best by supposing that the radiation of hot super-giants in the highest frequencies deviates notably from equilibrium conditions.

3) *Late K and M Dwarfs,* showing bright Ca+, H, and Fe+ lines. Bright reversal on [H] and [K] have been sporadically observed in the spectra of G-M giants. In this case the bright lines require more energy for excitation than the characteristic absorption lines and originate, therefore, at the higher levels.

4) *Nebular Sequence,* which embodies the majority of the O stars and extends to planetary and diffuse nebulae, and is connected with novae, P Cygni, and Bep stars.

Only a few peculiar stars are not included in these four sequences. It is noteworthy that except for a few late dwarfs, the main stellar sequence is free of emission-line stars.

Two limiting cases can be considered theoretically. The first one is that of a reversing layer where ionizations by collisions are negligible in comparison with radiative ionizations. In such a layer a bright line can originate in two ways only: a) by Rosseland's mechanism of fluorescence. The necessary condition—a high dilution of the exciting stellar radiation—can only be found in an atmosphere of nebular type (nebular sequence); b) if there exists a permanent or semi-permanent accumulation of particular atoms at the top of the atmosphere. The bright lines will require more energy for their excitation than the characteristic absorption lines, and, consequently, they will be of floccular or chromospheric type. We may reasonably suppose that Me or Ke dwarf stars as well as late giants showing reversed [H] and [K] are of such a type.

The other limiting case is that of an atmosphere where radiative captures and ionizations are negligible, and the reversing layer is, therefore, of a "purely collisional" type. Analysis of the ratio of emission to absorption for a given spectral line (which is independent of Einstein's coefficients) shows that in such atmospheres bright lines can originate only in the hottest stars (*e.g.* B-type), but it is doubtful whether such lines can normally be sufficiently intense. Calculations based on Kramer's, Milne's, and Fowler's theories of radiative captures and ionizations, as well as inelastic and super-elastic collisions, show that the ratio of the number of ionizations by collisions to that of radiative ionizations is larger than had been thought. For an A0 star at pressure 10^{-4} atm. it is 0.5; but at 10^{-2}, it is 50. Thus the bottoms of reversing layers are of "purely collisional" type, while the tops are of the first limiting "radiative" type.

In "purely collisional" atmospheres the factors favorable for the pro-

duction of bright lines are very much enhanced if the electron temperature (*i.e.* temperature as determined by the application of Saha's formula) is greater than the effective temperature. This is the case if the hard radiation released in the stellar interiors is not completely transformed into black-body radiation before reaching the stellar surface. This is very likely to happen, because Compton's effect is not an ideal mechanism for the transformation of high-frequency radiation into a normal form: the scattering by free rapidly moving electrons can in certain cases even increase the frequency of radiation traversing stellar strata. This additional hard radiation, superposed on the ordinary black-body radiation of a star, will, by repeated scattering processes, increase the energy of the electrons in the reversing layer, the excess of energy being carried off (for a star in a steady state by the radiation of emission lines and emission bands beyond the series limits). This hypothesis explains the correlation between bright lines in the F-B super-giant series and the above mentioned peculiar luminosity effect; it shows, moreover, why the stars on the main sequence (locus of stable thermo-dynamic configurations) are absorption-line stars, except for a few late dwarfs with emission lines of floccular type. Full quantitative analysis of such "super-excited" atmospheres permits the explanation of the formation of intense bright lines, as well as of the origin and even distribution of intensity of emission beyond the Balmer limit in the spectra of some Be stars, as discovered recently by Yü.

PHOTOMETRY AT THE AMHERST COLLEGE OBSERVATORY.

By Warren K. Green.

A wedge photometer was built for the Amherst College Observatory by the Gaertner Scientific Corporation during 1923. This instrument is similar in fundamental principle and design to the Rumford instruments, but embodies many improvements suggested by the late Professor Parkhurst and the writer. The most important is a self-recording device, which greatly increases the efficiency of the instrument. A sequence of fourteen stars, with six wedge-settings on each star, can be run through within forty minutes at the telescope; and the resulting sheet may be measured and reduced within fifteen minutes. The resulting magnitudes have a probable error of approximately 0.10 magnitude.

Observations for the calibration curve of the wedge have been made by three independent methods. Preliminary reductions indicate the surprising result that, within the probable error of the mean of six wedge-settings, the relation between wedge-setting and magnitude is linear over a range of slightly more than five magnitudes. The complete solution for the small departures from this linear relation have been postponed until the observations can be repeated to indicate

whether or not there is any variation in the wedge with time.

The instrument is being used to determine standard sequences, between magnitudes seven and fourteen, for the A.A.V.S.O.; and also to determine the magnitudes of a long sequence of comparison stars to use in connection with a projected study of the variability of asteroids.

THE BRIGHTER PSEUDO-CEPHEIDS.

By F. Henroteau.

ϵ *Aurigae:* Observed four or five months each year for the last four years. Radial velocity curves of small amplitude and a period of several months are found. The period, however, is not constant, nor the apparent center-of-mass velocity. The principal lines in the spectrum belong to simply ionized metals, especially iron and titanium. The ultimate lines of strontium, Sr+ 4078, 4216, and of scandium, Sc+ 4247, are very prominent. It is a typical F5 super-giant spectrum.

ρ *Puppis:* Very little variation in radial velocity, if any. Corrected for the solar motion in space this star has an approximate radial velocity of +64.2 km, the largest known positive velocity for a pseudo-cepheid. The hydrogen lines of the Balmer series are very prominent.

β *Draconis:* A variation in radial velocity is present, but any effort to find a period of variation has proved futile. The velocity ranges from —17.1 km to —27.7 km.

ν *Herculis:* Three plates were secured. If the radial velocity varies, it is by a small amount.

γ *Cygni:* The radial velocity of γ Cygni appears to be constant. At any rate, if there is a variation, it cannot amount to more than four or five kilometers and should be of long period.

It is exceedingly important, however, that this star be investigated with high-dispersion spectrographs, for if a good radial-velocity curve could be obtained, together with a light curve, it might be one of the rare cases of super-giant stars for which information as to size, density, and parallax could be obtained. According to Guthnick it is indeed highly probable that the star is an eclipsing variable. He found with the photo-electric photometer that in November, 1917, an Algol-type depression of light occurred, lasting approximately ten days and having a depth between $0^M.05$ and $0^M.06$. At any other time the light was found to remain constant.

σ *Cygni:* The spectroscopic elements of the orbit, which were determined by the writer at the Detroit Observatory in 1916 are being revised. Among the most remarkable lines in the spectrum are those of Si+ 4131, 4128 which are quite strong, having the same intensity as the ever-present magnesium line Mg+ 4481. The Balmer series of hydrogen lines is represented by many lines, which are the most conspicuous.

α Cygni: A decided variation of velocity is present although the amplitude is small. No period was found and it is certain that the variation is irregular. Compared to σ Cygni, where the variation is regular, due apparently to a very small companion, the suggestion follows that in cases of super-giant stars similar to α Cygni and β Draconis, with irregular radial-velocity variation, there are perhaps two or more small companions. Although the silicon lines are still prominent in the spectrum, no helium lines have been found. The metallic lines, especially those of ionized elements, are stronger than in σ Cygni.

These results will be discussed at length in the *Publications of the Dominion Observatory.*

SPECTROPHOTOMETRY OF CLASS-M STARS.

By Frank S. Hogg.

Preliminary results of a photometric study of the spectra of nine M stars are discussed. The material is too incomplete to allow any very definite conclusions, although the measures are of satisfactory accuracy.

The summed intensities of six of the more conspicuous bands of titanium oxide show a good correlation with the Mount Wilson spectral subdivisions of M stars, based on visual estimates of titanium oxide absorption.

As predicted by theory the bands of different order show quite different relative intensities progressively along the sequence. The variation in relative intensity of the (1, 0) and (5, 2) bands with spectral class is conspicuous. Direct determinations of temperature from the relation should be possible when investigations of the structure of the molecule of titanium oxide have been completed.

In consideration of this different behavior it seems probable that the intensity of the four strong bands (0, 1), (0, 0), (1, 0), (2, 0), is less involved, as a classification criterion, than are attempts to estimate total absorption of titanium oxide. Of these the (1, 0) band at 4955 and the (2, 0) band at 4762 are the only ones in the photographic region. The total intensity of these bands might serve as a classification, as little change in relative intensities should be expected, and hence it would be a function of the molecular dissociation.

As a check on the physical relations in the arbitrarily defined Mount Wilson classes, the values of the ratio of intensities of Ca and Ca+ are plotted against spectral class, and show a correlation; calcium becomes relatively weaker as later M types are considered, while atomic theory predicts the reverse effect as a result of falling temperature. The discrepancy might be attributed either to a lessening of the calcium present, by entering into chemical combination, or to increasing ionization, due to low pressure. Further knowledge of the dissociation of

titanium oxide, and the effects of temperature on its spectrum, should show whether either of these two possibilities satisfies the necessary conditions.

The star α Tauri, of Class K4, was also measured. It shows the more conspicuous of the titanium oxide bands, and would appear to be classified much too early as judged by the summed intensities of these bands. This indicates that possibly while the band classification evidently forms a sequence similar to the one defined by line intensities, the sequences may overlap. As the Ca/Ca+ ratio has evidently a turning point in the K stars, a possible overlapping could not be definitely detected by means of this ratio.

NOTE ON SILICON AND STRONTIUM STARS IN CLASS A OF HARVARD CATALOGUE.

By C. Hujer.

The Henry Draper Catalogue contains about 200 stars marked as peculiar, mostly belonging to spectral class A. "Silicon stars" are characterized by the lines λλ4128, 4131, of ionized silicon, and "Strontium stars", by the lines λλ4078, 4215 of ionized strontium. Unusually high intensities of the Si and Sr lines were supposed to be closely correlated.

At the suggestion of Professor E. B. Frost these stars were examined throughout class A and the later subdivisions of type B. All the spectrograms of these types down to apparent magnitude 5.5, taken at Yerkes Observatory with the Bruce spectrograph of the 40-inch refractor were analyzed for this purpose on the Hartmann spectrocomparator. I have examined the best spectrograms of about 350 stars of classes A and B. The intensities of Si 4128, 4131, Sr 4078, 4215, and Mg 4481 were estimated on an arbitrary scale. The intensity of the silicon line 4128 in 49b Cancri was called 10. Complete absence of the line was designated by 0. The method of estimates closely agrees with that used by Dr. Struve in his study of detached calcium lines. The Yerkes slit-spectrograms, with their high dispersion, have permitted an accurate spectral classification, based on the intensities of the metallic lines, by a method similar to that suggested by Adams and Joy (*Ap. J.*, **56**, 243). The [H] and [K] lines, which form the basis of the Harvard classification could not be used as they lie too far from the region of best definition of the Yerkes spectrograms. Distinct differences from the Harvard classification were noted in a good many cases. The character of the lines is indicated by the letters s (sharp) and n (nebulous).

The relation between the silicon lines and the strontium lines is not quite so definite as had been supposed. The most intense silicon lines were found in the types from A0 to A3, in agreement with a statement of Miss Payne in her book on *Stellar Atmospheres*. Some stars, such

as 21 Persei, of type A1s, or 43 Cassiopeiae, of type A0n, show both the silicon and strontium lines of about equal, moderate, intensity, while other stars, like 17 Aurigae, of type A0s, and 36 τ^9 Eridani, of type A1s, which have silicon lines of nearly maximum intensity, scarcely show any trace of the strontium lines. Yet not one star with unusually strong strontium lines was found in the early A types with the silicon lines absent. The occurrence of the strong silicon lines $\lambda\lambda$4128, 4131 in the early A-type stars appears to be a definitely abnormal phenomenon, and these so-called "silicon stars" can hardly be included within the normal class-A sequence.

These stars are scattered all along the galaxy and do not form separate, localized groups.

INTERFEROMETER MEASUREMENTS OF WAVE-LENGTHS IN THE VACUUM-ARC SPECTRA OF TITANIUM AND OTHER ELEMENTS.

By C. C. Kiess.

Titanium lines are present in the spectra of the sun and stars and the titanium spectrum is used as a standard reference spectrum. Considerable work has been done in determining the wave-lengths of iron with high precision, but the spectrum of titanium has been comparatively neglected. Previous interferometer measures on titanium cover only a portion of the region of astrophysical importance; the present work applies to more than one octave of the spectrum, and gives standard wave-lengths for about 300 vacuum-arc lines from 2941A, in the ultraviolet, to 6743A, in the red. For many of these lines the accuracy of measurement exceeds one part in 6,000,000, and for the majority it exceeds one part in 4,500,000. From the known series relationships of the lines, it has been possible to compute the terms involved in their production, using for this purpose only the wave-numbers of lines measured in the vicinity of the neon standards, and the constant term separations as determined in various parts of the spectrum. From these terms the wave-lengths of the blue and violet lines have been calculated, and their agreement with the observed values shows that no difference in scale exists between the red and violet regions. In addition to titanium, some wave-lengths of iron, copper, calcium, barium and other elements were also measured.

RECENT RADIOMETRIC OBSERVATIONS OF THE PLANETS.

By C. O. Lampland.

With a large radiometer of special type, constructed for measurements on the moon, all points of the lunar surface may be readily observed with the compensated type of thermocouples. Seven transmission

screens are now used and measurements for different parts of the surface over the complete lunation should bring important data on our satellite. Several regions have already been observed at some length.

Extensive measurements have been made on Mercury but the series still has gaps in some parts of the orbit. Most of the measurements are for the integrated radiation of the disk, and the next step in the work will be to analyze restricted areas of the surface, and to make further tests on the dark part of the disk.

The planet Venus has also been observed at length but the series of measures has gaps in the different presentations of the planet's surface. Radiometric observations carried out over an extended period indicate that conditions over the surface vary considerably from time to time. Recent photographs of the planet, made here and elsewhere, show considerable variability of surface detail and this in itself suggests that one might expect a changeable intensity as well as some variation of the spectral quality of the radiation observed from different parts, as shown by the radiometer.

Systematic measures on the planet Jupiter this past autumn gave the unexpected result that the water-cell transmission of parts of the planet in many cases exceeded the water-cell transmission of the directly observed solar radiation by as much as 5 to 10 per cent. Checks were sought through as many independent sources as possible in regard to the performance of the apparatus and the manner of making the observations, and thus far no reasons have been found for not accepting the results as real.

There appear to be reasonable arguments to offer in support of transmissions, for some of the planets, higher than observed for the direct solar radiation. A value for the water-cell transmission the same as found for sunlight would imply non-selective reflection, or that the albedo is the same for all parts of the spectrum. Except in the case of the earth's atmosphere it is not known to what extent atmospheric absorptions invade the invisible infra-red regions of the spectra. If, in this region, additional absorptions are introduced by the atmosphere of Jupiter, the high water-cell transmission of this planet would be explained.

During the past weeks the south polar zone has consistently given readings from 25 to 50 per cent higher than the north polar zone. And generally speaking, the water-cell transmission is a few per cent lower for the south polar zone.

At the present opposition the north and south tropical belts are conspicuous in their contrast, the south one much brighter visually and photographically than the north one. The total energy is considerably greater for the south one, and as might be anticipated, the water-cell transmission is also higher.

RADIOMETRIC OBSERVATIONS OF SKJELLERUP'S COMET.

By C. O. Lampland.

An effort was made last summer to observe the radiation from the Pons-Winnecke comet but the energy was too feeble to obtain results. In the present case, even with the great mirror partially covered to keep off the direct sunlight, the deflections were large enough to obtain quantitative results for the different transmission screens. It is perhaps particularly true in a case such as the present one that the greater the number of spectral bands one can isolate, the more valuable may be the data. In a comet the distribution of energy in the spectrum may deviate considerably from the "full radiator" energy distribution.

The present measurements may be said to refer practically wholly to the nucleus, as a small receiver was used.

The radiometric measurements have just been made and there has been no opportunity to attempt their possible interpretation. The extension or extrapolation of laboratory results would need careful consideration. Infra-red radiation measurements of the emissions and absorptions of carbon monoxide and other cometary constituents have been made but the great differences in the conditions of the two experiments might vitiate interpretations based on them as applied to the actual case of a comet.

The very great changes that took place in the distribution of the energy in that part of the spectrum transmitted by the earth's atmosphere, 0.3μ to 14.5μ is at once evident from the variation in the values for the different transmission screens. With only water-cell transmission measurements one might immediately have concluded that on December 16, the radiation was wholly reflected sunlight, but the measurements with the Pyrex and quartz screens indicate that a considerable part of the energy was found in the spectral region between 3μ and 4μ.

On the three following dates, December 17, 18, and 19, there was a great increase in the infra-red percentage of the energy. When, on the second day, the transmission of the water-cell was found to be only about 40 per cent instead of the 75 per cent which it had been on the previous day, it became evident that the radiation from the comet had undergone a change in spectral quality. Communication with the 24-inch telescope then brought the information that bright sodium lines of high intensity had made their appearance since the spectrographic observations of the previous day.

The radiometer should be a useful aid in unraveling some of the mysteries of cometary activities in that it will be possible to deal with radiations beyond the range at present within grasp of the spectrograph. It is important that search be made for the most useful transmission screens for isolating spectral regions, in order to localize the radiation.

SOME RESULTS OF THE WORLD LONGITUDE WORK OF 1926.

By F. B. Littell and J. C. Hammond.

This work brought about a widespread coöperation of observatories. At San Diego, one of the links in the original primary chain, which included also Algiers and Shanghai, the transit was mounted in the open air, the spirit level was checked by frequent determinations and by comparison with the nadir observations, a meridian mark controlled the variations of the azimuth constant, reversal on each star eliminated the collimation, constant pressure and temperature kept the Riefler clock regular, the use of the transit micrometer reduced the personal equations to a minimum and personal equation apparatus enabled the observers to measure that.

All recording, both time signals and star observations, was done on the same chronograph so that all lags of relays were eliminated, except that of one intervening between the radio and the chronograph. This lag was measured and the necessary corrections applied. The arrangements at San Diego and Washington being almost identical, the difference of longitude between these points should be quite free from systematic errors. For each of 8 different series of radio signals there were sufficient data to give an accurate result, and there is practically no difference, whether the signals were long or short wave, weak or strong, American code or rhythmic. The mean of all the values is $2^h\ 40^m\ 32^s.625 \pm 0^s.0017$. The differences of longitude between the 3 stations, San Diego, Algiers, and Shanghai, were as follows, the closing error being $0^s.002$:

	h m s	s
San Diego - Algiers	8 00 56.902	± 0.0020
Algiers - Shanghai	7 53 34.365	± .0029
Shanghai - San Diego	8 5 28.731	± .0025

The Washington - Greenwich longitude is $5^h\ 8^m\ 15^s.753 \pm 0^s.0013$ and the Washington - Paris longitude is $5^h\ 17^m\ 36^s.665 \pm 0^s.0019$. The latter is in excellent agreement with that obtained in 1913-14 by radio, which was $5^h\ 17^m\ 36^s.653 \pm 0^s.0031$.

The values of the transmission velocities, assuming that travel was near the earth, and on a great circle, are as follows:

Longitude Stations	Radio Stations	No. Nights	Miles per second
San Diego, Washington	Annapolis, Honolulu	31	178000 ± 14000
San Diego, Washington	Bordeaux, Honolulu	18	164000 ± 23000
San Diego, Paris	Annapolis, Bordeaux	27	129000 ± 5000
San Diego, Shanghai	Saigon, Honolulu	29	197000 ± 12000
San Diego, Algiers	Annapolis, Bordeaux	29	125000 ± 5000
Washington, Greenwich	Annapolis, Bordeaux	49	138000 ± 4000
Washington, Paris	Annapolis, Bordeaux	50	129000 ± 4000
Washington, Paris	Annapolis, Bordeaux	44	124000 ± 3000
Washington, Algiers	Annapolis, Bordeaux	45	139000 ± 5000
Washington, Algiers	Annapolis, Bordeaux	45	142000 ± 5000

(To be continued.)

THE ORBITS OF MARS AND EROS.

By FREDERIC R. HONEY.

The interest in the little planet Eros, which comes very near the earth when an opposition occurs in the month of January, has naturally called attention to its relations with its close neighbor Mars. The projections of their orbits on the plane of the ecliptic (Fig. 1) suggest complex conditions. An examination, however, which may be made graphically, sets at rest any doubt as to the possibility of a too close proximity which, since the plane of the orbit of Eros is inclined at an angle which is nearly six times that of Mars, must be sought at or near the line of intersection of the orbit planes.

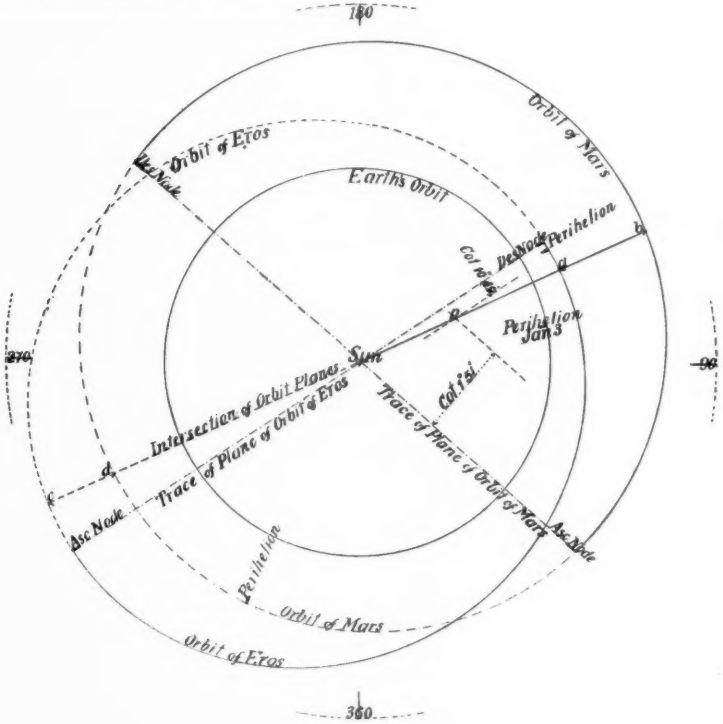


FIGURE 1.

In a drawing of these small dimensions the projection of the orbit of Mars does not differ sensibly from its true form; and that of Eros

causes a very small diminution of the minor axis of the ellipse; since its major axis is very near the line of nodes, it is practically represented in its true length.

To find the intersection of two planes, whose traces and inclinations (α and β) are given, is a one plane descriptive geometry problem. The analysis of the construction is shown in Figure 2. Let p be a point at any assumed distance P from the ecliptic; and let pa and pb form with the ecliptic the angles α and β. The distances from the foot of the perpendicular to a and b measure the distances to the traces which are respectively equal to $P \cot \alpha$ and $P \cot \beta$. Since P represents any distance from the ecliptic, the measurements in Figure 1 may be any convenient multiple of cot α and cot β. Lay off these distances on perpen-

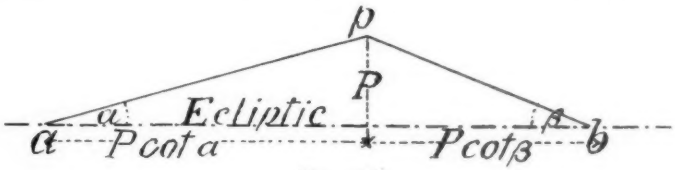


FIGURE 2.

diculars to the traces of the orbit planes, and through these points draw parallels to the traces. They intersect at p, a point common to both planes; and a line drawn from this point to the intersection of the traces, *i.e.* to the sun, determines the intersection of the planes. The full line represents the intersection above the ecliptic; and its continuation on the other side of the sun the intersection below; and the measurements ab and cd the distances between the orbits measured along the line of intersection.

TRINITY COLLEGE, HARTFORD, CONNECTICUT.

HEAVENLY ZOO.

Cetus.

This greatest of cetacea,
That nearly got Andromeda,
Swims with the heavenly voyagers.
His Mira-star, now dark, now bright,
Is an enigma of the night
Intriguing to astronomers.

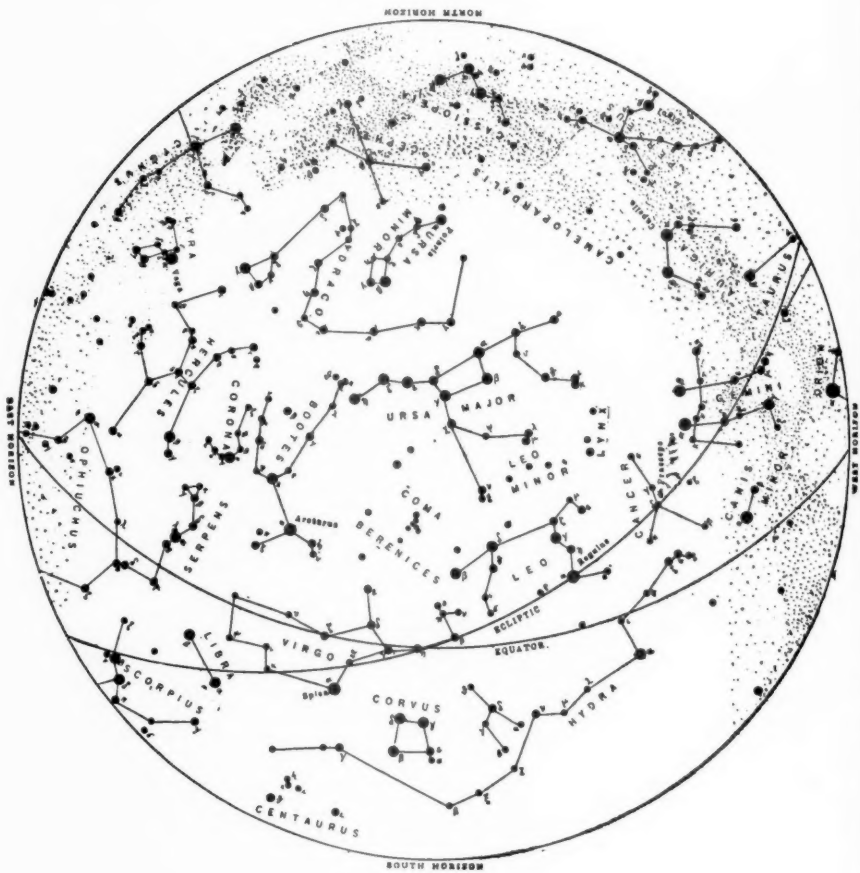
Columba.

Low on horizons south of us
This little inconspicuous
But storied Dove flies through the dark.
There is not much to tell, at that,
Yet, once, it perched on Ararat:
Noah sent it questing from the Ark.

1490 Stuart St., Denver, Colorado. LILIAN WHITE SPENCER.

PLANET NOTES FOR MAY.

By CLIFFORD E. SMITH.



THE CONSTELLATIONS AT 9:00 P.M. MAY 1.

The *Sun* will continue to move northeast. At the beginning of the month it will be in the central part of Aries, and during the month it will cross to the central part of Taurus about six degrees north of the bright star Aldebaran. On May 19 there will be a total eclipse of the sun which will be invisible in the northern hemisphere. Details of the eclipse may be found in the *American Ephemeris* for 1928 or in POPULAR ASTRONOMY in the January number of this year, page 40.

The position of the sun on May 1 and on May 31 will be respectively, R.A. $2^h\,32^m$, Decl. 14° 56′; and R.A. $4^h\,30^m$, Decl. 21° 51′.

The phases of the *Moon* will occur as follows:

Full Moon	May	4 at 2	P.M.	C.S.T.
Last Quarter		12 " 3	P.M.	"
New Moon		19 " 7	A.M.	"
First Quarter		26 " 3	A.M.	"

The moon will be at apogee (farthest from the earth) on May 5, and perigee (nearest the earth) on May 19.

Mercury at the beginning of the month will be in the central part of Aries, and during the month it will move to the eastern border of Taurus. On May 3 Mercury will be at superior conjunction. Thus on that date it will rise and set with the sun, but by the end of the month it will have moved so that it will set about an hour and forty minutes after the sun. On May 8 Mercury will pass through perihelion.

Venus during the month will move from the western border of Aries to the western part of Taurus. Venus is approaching superior conjunction. During the middle of the month it will rise about an hour before the sun.

Mars will be in Pisces, moving from the western edge to the central part of the constellation. At the end of the month it will rise about 2:00 A.M. Standard Time. On May 24 Mars will be in conjunction with Uranus. At this time Mars will be about a degree south of Uranus.

Jupiter will be in Pisces near the eastern border. At the end of the month it will rise about 3:00 A.M. Standard Time which will be approximately an hour after Mars will rise.

Saturn will be in the extreme southern part of Ophiuchus about ten degrees east of Antares (α Scorpii). Saturn is approaching opposition, and at the middle of the month it will be on the meridian about 1:30 A.M. Standard Time.

Uranus will be in the central part of Pisces. During the latter part of the month Uranus and Mars will rise together at about 2:00 A.M. Standard Time.

Neptune will be in Leo about two degrees west of Regulus. On May 17 Neptune will be in quadrature east of the sun and at that time it will be near the meridian at sunset.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1928	Star's Name	Magnitude	IMMERSION. Washington C.T.	Angle from N	EMERSION. Washington C.T.	Angle from N	Duration
			h m	°	h m	°	h m
May 3	2 Librae	6.3	21 59	101	23 17	333	1 18
25	42 Leonis	6.1	20 49	172	21 35	251	0 46
29	65 Virginis	6.0	18 55	127	20 20	310	1 25
29	66 Virginis	5.7	20 1	126	21 28	312	1 27
30	*l* Virginis	4.8	1 55	97	2 56	312	1 0
30	96 Virginis	6.5	20 36	137	22 2	298	1 26

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928 May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8							27	11
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	8	1	15	5	22	9	29	13
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	6	23	14	11	21	22	29	10
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	2	0	8	2	20	8	26	11
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	6	4	11	21	23	8	29	1
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	2	1	8	22	22	15	29	12
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	1	21	11	11	21	1	30	14
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	6	21	14	20	22	18	30	17
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6							29	13
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8			8	18	17	9	26	0
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	4	0	9	23	21	20	27	18
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	6	9	14	7	22	4	30	2
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	5	15	13	23	22	6	30	13
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	4	11	10	9	22	5	28	4
RW Persei	13.3	+42 04	8.8—11.0	13 04.8			10	9	23	13		
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	6	1	12	9	24	23	31	6
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1			8	17	21	3		
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	3	5	13	7	19	20	30	21
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	2	1	12	23	18	9	29	7
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4	16	10	17	22	18	28	18
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	3	22	10	10	23	10	29	22
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	1	5	11	14	16	19	27	5
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	2	2	10	2	18	2	26	2
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	5	8	11	2	22	14	28	7
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	3	17	9	23	22	10	28	15
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3	4	10	1	23	16	30	12
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	1	11	9	2	24	8	31	23
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	1	23	14	4	26	8		
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	1	13	8	17	23	1	30	5
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	2	16	9	12	23	3	29	23
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	5	20	15	3	24	10		
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	7	1	13	16	20	7	26	21
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	6	11	14	20	23	6	31	16
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	7	10	13	20	20	6	26	17
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	3	8	10	15	17	21	25	4
X Carinæ	8 29.1	—58 53	7.9— 8.7	0 13.0	6	20	13	20	20	21	27	22
S Cancri	8 38.2	+19 24	8.2—10	9 11.6			9	12	19	0	28	11
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	1	22	11	1	20	4	29	7
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	2	21	8	18	20	15	26	13
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7	6	14	1	20	18	27	12
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	5	7	12	17	20	3	27	13
SS Carinæ	54.2	—61 23	12.2—12.8	3 07.2	6	15	13	5	19	20	26	10
RW Urs. Maj.	10 35.4	+52 34	10.3—11.4	7 07.9	3	19	11	2	18	10	25	18
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	1	23	8	18	22	8	29	3
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	6	19	14	8	21	20	29	8
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	2	12	12	2	21	16	31	7
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	6	19	14	6	21	16	29	3

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928					
					May					
	h m	° ′		d h	d h	d h	d h	d h	d h	
SX Hydræ	13 39.0	−26 23	8.6—12.7	2 21.5	2 5	13 19	19 14	31 4		
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	6 9	13 9	20 8	27 8		
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	5 2	11 23	18 21	25 19		
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.4	6 7	14 17	23 3	31 13		
SS Libræ	15 43.4	−15 14	9.3—11.5	0 18.4	2 13	9 17	24 2	31 7		
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	5 2	12 11	19 19	27 3		
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	4 17	10 22	23 7	29 12		
R Aræ	31.1	−56 48	6.8— 7.9	4 10.2	4 16	13 13	22 9	31 5		
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		9 9		30 3		
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	3 10	10 5	23 19	30 15		
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	1 16.2	7 0	13 17	20 10	27 3		
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 16	9 20	22 3	28 7		
TX Herculis	15.4	+42 00	8.3— 9.0	2 01.4	2 18	8 22	21 7	27 11		
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	6 4	13 13	20 23	28 7		
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	1 18	11 13	21 9	31 5		
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	5 3	11 18	24 22	31 13		
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2		9 23	20 19	31 15		
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	1 17	9 16	17 16	25 16		
WX Sagittarii	53.6	−17 24	9.2—10.8	2 03.1	1 16	8 1	20 19	27 5		
WY Sagittarii	17 54.9	−23 01	9.5—10.6	4 16.0	4 19	14 3	18 19	28 4		
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	5 23	16 7	21 11	31 19		
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	3 1	10 7	17 13	24 18		
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	4 10	11 7	18 5	25 3		
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		16 1		31 5		
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 12	10 5	17 22	25 15		
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	4 0	12 21	21 19	30 16		
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	5 3	13 11	21 18	30 1		
RR Draconis	40.8	+62 34	9.3—13	2 19.9		9 2	17 14	26 2		
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	7 6	15 5	23 5	31 4		
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8		8 4	21 2			
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	1 13	9 4	16 20	24 11		
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	7 18	15 8	22 22	30 11		
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	1 21	9 1	23 11	30 16		
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4		8 20	17 19	26 18		
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	2 12	9 6	22 19	29 13		
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	6 3	13 12	20 21	28 6		
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	3 15	14 3	19 9	29 20		
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1		9 17	17 21	26 3		
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	4 4	10 4	22 5	28 5		
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6		8 14	18 12	28 11		
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	2 2	11 5	20 9	29 12		
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	2 13	10 23	19 10	27 20		
RW Cancri.	12.2	−17 59	8.8—10.6	3 09.4	3 15	10 10	24 0	30 19		
UW Cygni	19.6	+42 55	10.5—13	3 10.8	3 14	10 12	24 7	31 4		
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	6 14	16 5		25 19		
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	1 9	10 14	19 19	28 23		
Y Cygni	48.1	+34 17	7.1— 7.9	2 23.9	6 8	12 8	24 8	30 8		
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	7 19	14 22	22 2	29 5		
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	1 20	11 22	16 16	27 2		
RY Aquarii	21 14.8	−11 14	8.8—10.4	1 23.2	4 6	10 4	21 23	27 20		
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3			19 10			
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	2 8	12 11	17 13	27 17		
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	5 13	15 22	21 2	31 11		
VW Pegasi	22 51.7	+32 42	10.0—10.6	5 06.4	1 2	11 16	16 23	27 13		
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	4 16	12 5	19 17	27 6		
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	2 23	11 5	19 11	27 17		

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Maxima in 1928							
							May					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	3 11							
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	3 4	11 7	19 10	27 14				
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	6 3	11 16	22 18	28 6				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		13 14		28 10				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	3 19	10 18	24 15	31 14				
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	2 10	10 5	18 0	25 20				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	3 0		19 10					
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	3 18	12 7	20 21	29 11				
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1		9 11	20 14	31 17				
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	6 5	17 20		29 11				
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	2 1	8 4	20 10	26 13				
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3		9 1	19 5	29 8				
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	7 15	15 9	23 2	30 19				
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	2 9	13 10	18 23	30 0				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	4 3	11 16	19 6	26 20				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3		10 11						
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	1 20	9 7	24 5	31 16				
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	2 2	10 0	17 22	25 20				
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	5 13	15 16		25 20				
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	6 23			29 2				
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3 16	11 14	19 13	27 12				
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	4 5	10 22	24 7	31 0				
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	1 16	10 23	20 6	29 13				
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	1 1	9 19	18 13	27 7				
Z Leonis	9 46.4	+27 22	7.9— 9.6	56 08.7		12 12						
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	4 12	13 13	22 14	31 15				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	4 19	11 9	24 14	31 5				
S Muscæ	12 07.4	—69 36	6.4— 7.3	9 15.8	5 8	15 0	24 15					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	6 0	11 16	23 2	28 18				
T Crucis	15 9	—61 44	6.8— 7.6	6 17.6	2 12	9 5	22 16	29 10				
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	5 20	11 16	23 7	29 3				
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	1 15	11 0	20 9	29 18				
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5	1 11		18 17					
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	7 7	15 12	23 17	31 22				
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2		10 6	19 15	28 23				
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	2 13	10 18	18 23	27 4				
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	4 2	15 2	20 14	31 14				
RS Bootis	14 29.3	+32 11	8.9—10.0	0 09.1	7 13	15 2	22 15	30 4				
R Trian. Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	2 10	12 14	19 9	29 13				
S Trian. Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	1 12	7 20	20 11	26 19				
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1		10 8	20 3	29 21				
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	6 13	13 5	21 20	26 11				
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	1 16	13 19	19 20	31 23				
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	3 1	10 1	24 2	31 2				
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	3 7		20 10					
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3		8 13	16 3	23 17				
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	3 23	9 18	21 7	27 2				
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	2 19	9 13	23 1	29 19				
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	4 9	14 18	25 2					
RZ Lyræ	39.9	+32 42	9.9—11.2	0 12.3	1 22	9 14	17 6	24 22				
RT Scuti	44.1	—10 30	9.1— 9.7	0 11.9	5 18	13 4	20 15	28 1				
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2		8 13	17 15	26 17				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Maxima in 1928 May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	3 11	10 12	17 12	24 13				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	5 4	12 4	19 4	26 4				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	3 18	11 17	19 17	27 17				
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 15	11 7	22 20	30 13				
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	3 5	10 9	17 13	24 17				
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	3 1	11 10	19 19	28 4				
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	2 15	8 23	21 14	27 21				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3		12 15		28 23				
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	2 11	11 8	20 15	29 1				
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	2 14	13 19	19 10	30 15				
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	4 14	13 12	22 11	31 10				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4		13 1		27 18				
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	7 17	15 14	23 10	31 7				
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	3 6	12 10	21 15	30 19				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 20	12 14	17 11	27 4				
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	4 17	13 8	22 0	30 16				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	3 6	14 0	19 9	30 2				
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	2 21	13 19	24 16					
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	5 8	11 17	24 13	30 23				
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	1 6	11 5	21 4	31 3				
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	2 2	13 0	18 10	29 8				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	4 7	15 4	20 15	31 12				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	4 19	11 2	23 16	29 23				
RY Cassiop.	23 47.2	+58 11	9.3—11.8	12 03.4		9 17	21 20					

Monthly Report of the American Association of Variable Star Observers, for the Month of February, 1928.

In spite of the cloudy conditions which prevail, in general, during the winter months, our records maintain a good average, both in quantity and quality. We welcome the return to the active list of two observers, Messrs. Pickering and Waldo. Their observations were made at the observatory of Mr. Waldo where there is an excellent 9-inch Brashear reflector. We are also pleased to acknowledge the maiden list of Mr. C. DeF. Swanson, of Montclair, N. J. Mr. Sigeru Kanda, of Japan, also sends in a good contribution after a long silence.

The Bigelow 5-inch outfit has been loaned to Mr. G. Watkins of Caldwell, Idaho, in appreciation of his splendid efforts at observing with his own much smaller instrument. The C. C. Godfrey instruments are all in new locations; the 11-inch in the hands of Mr. J. H. Logan of Dallas, Texas, the 8-inch with Mr. Kurtz in Bethlehem, Pa., and the two 10-inch mirrors, mounted up by Messrs. Allen and Cunningham, at Auburndale and Cohasset, Mass., respectively.

The C. Y. McAteer Library—whose value has been greatly enhanced by the addition of the C. C. Godfrey Memorial books—has been completely revised by Mr. R. O. Suter and is now available for loan to our members. This will be greatly facilitated by the issuance of the new catalogue which is now in progress of preparation by the Library Committee. This library contains one of the best collections of up-to-date astronomical books probably to be found in any astronomical association in the country and its use should be more generally extended.

Both U Geminorum and SS Aurigae have been in the lime-light since the

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

Dec. 0 = J.D. 2425215; Jan. 0 = J.D. 2425246; Feb. 0 = J.D. 2425277.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
V SCL			**T AND**			**RW AND**			**S CAS**			**X CAS**			**o CET**		
000339			001726			004132			011272			014958			*021403*		
222	11.3	Bl	269	9.0	Pt	260[	13.7	Ch	260[	13.2	Ch	273	11.6	Bn	238	6.5	Kd
229	11.2	Bl	271	9.2	B	**V AND**			273[	11.5	Ya	290	11.6	Bn	239	6.9	Ch
236	10.6	Bl	274	9.5	Wk	004435			**U PSC**			**U PER**			240	6.8	Kd
S SCL			283	9.7	Cl	219	9.4	Bg	011712			015254			242	7.0	Ch
001032			289	9.9	Ya	222	9.4	Bg	255	12.4	Lg	259	10.1	B	243	6.3	En
207	7.8	Kd	**T CAS**			229	9.4	Bg	269	12.8	Pt	261	10.2	Ch	244	6.8	Kd
208	7.9	Kd	001755			239	9.7	Bf	269	14.0	Lg	269	9.6	Pt	245	6.7	En
212	8.1	Kd	250	11.3	L	246	9.7	Bf	**R SCL**			272	9.8	B	246	6.9	Kd
216	7.9	Sm	256	11.9	Ch	250	10.0	GC	*012233a*			290	8.7	Al	252	6.6	L
222	8.3	Bl	260	11.2	L	261	10.1	B	201	8.2	Kd	**R ARI**			255	7.4	Ch
224	8.7	Ht	261	10.9	B	275	10.7	GC	234	8.0	Kd	021024			259	7.6	Ch
225	8.4	En	266	11.1	Wk	284	11.3	B	238	7.9	Kd	199	9.9	Sw	260	7.3	Wk
226	8.3	Sm	269	10.7	Pt	**X SCL**			270	7.3	Kd	200	9.8	Sw	261	7.6	Kd
226	8.5	Kd	269	11.2	Ya	*004435*			**RZ PER**			204	9.6	Sw	261	7.5	Jo
229	9.0	Bl	270	10.8	L	222	10.5	Bl	012350			205	9.5	Sw	262	7.7	Wk
230	8.8	Ht	274	10.9	Wk	229	10.6	Bl	271	10.1	By	211	9.5	Sw	262	7.7	Ch
233	8.1	Sm	**R AND**			236	10.6	Bl	272	9.6	Sp	239	8.4	Ch	263	8.2	Gy
234	8.9	Kd	001838			**RR AND**			273	9.7	Ya	252	9.2	Sw	264	7.5	Kd
234	9.0	En	260	12.2	Ch	004533			275	9.9	By	258	9.1	Ch	266	7.6	Kd
235	8.9	Kd	267	10.8	Fd	219[	12.7	Bg	284	9.6	B	260	10.1	Wk	266	7.6	Wk
236	9.3	Ht	269	11.4	Fd	229	15.1	Bg	289	9.6	Sp	266	10.2	Wk	266	7.3	L
236	9.2	Bl	269	11.9	Pn	**RV CAS**			**R PSC**			267	9.8	Fd	269	7.1	Pt
238	8.9	Kd	269	12.3	Pt	004746a			012502			267	9.6	Gb	269	7.5	Jo
242	9.1	En	287	13.5	B	262[	13.3	B	222	9.6	Bg	268	10.1	Fd	270	7.8	Kd
244	9.6	Ht	**S TUC**			—	CAS		232	8.5	Bg	268	9.7	Pn	283	8.6	Gy
X AND			*001862*			004746b			239	7.7	Bf	269	10.2	Pt	290	8.1	Al
001046			227	13.4	Bl	269	10.5	Pt	240	7.6	Ch	272	9.7	B	**S PER**		
219	13.0	Bg	233	13.0	Sm	**W CAS**			246	7.2	Bf	278	10.4	Fd	021558		
222	13.1	Bg	242[	13.2	En	004958			262	7.5	Ch	286	10.7	Fd	241	9.4	Ch
229	13.2	Bg	**S CET**			261	9.8	Jo	267	8.3	Al	289	10.8	Fd	250	9.3	GC
231	13.5	Bf	*001909*			269	10.0	Jo	269	7.5	Pt	**W AND**			252	9.6	By
239	13.8	Bf	263[	10.1	Wk	269	10.8	Pt	273	7.8	Ya	021143a			255	9.8	By
246	14.2	Bf	267	12.8	L	271	10.1	B	277	8.0	Al	261	11.4	Ch	256	10.0	By
255	13.5	Lg	269[	10.4	Wk	**U TUC**			**RU AND**			269	11.9	Pt	257	9.8	By
275[	12.8	GC	**T PHE**			*005475*			013238			273	10.2	B	261	9.5	Ch
T CET			*002546*			216[	12.5	Sm	239	10.6	Ch	**T PER**			263	9.8	By
001620			216[	12.2	Sm	227	14.2	Bl	255	10.8	Lg	021258			269	9.7	By
207	6.7	Kd	226	13.0	Sm	234[	13.7	En	260	11.3	Ch	241	8.9	Ch	269	9.0	Pt
209	6.7	Kd	227	12.2	Bl	242[	13.7	En	263	11.1	B	261	9.3	Ch	272	10.2	By
213	6.4	Kd	233	12.4	Sm	**Z CET**			266	11.1	Lg	269	8.9	Pt	273	9.3	Ya
225	6.6	Kd	236	12.4	Bl	*010102*			269	11.3	Pt	**o CET**			275	9.9	By
228	6.3	Kd	242	12.3	En	269	13.3	Pt	273	11.5	Lg	*021403*			284	9.4	B
234	6.2	Kd	**T PSC**			**U SCL**			284	11.8	Lg	207	5.8	Kd	290	9.3	Al
235	6.2	Kd	002614			*010630*			**Y AND**			208	5.9	Kd	**R CET**		
239	6.3	Kd	257	12.2	GC	227[	14.0	Bl	013338			209	5.9	Kd	*022000*		
258	6.9	L	**W SCL**			**U AND**			239	9.7	Ch	212	6.0	Kd	240	10.4	Ch
264	6.5	Kd	*002833*			010940			260	11.1	Ch	216	6.1	Kd	260	11.4	Ch
266	6.5	Kd	227	13.1	Bl	255	12.8	Lg	263	11.8	B	225	6.1	Kd	269[	12.5	Kz
270	6.5	Kd	**U CAS**			261	11.9	B	269	13.0	Pt	225	5.9	En	**RR PER**		
T AND			004047			266	11.9	Lg	**X CAS**			226	6.2	Kd	022150		
001726			263	8.5	Wk	273	11.0	Lg	014958			228	6.2	Kd	261[	11.9	Ch
239	8.8	Ch	266	8.7	Wk	284	10.8	Lg	263	10.6	B	231	6.5	Kd	**R FOR**		
251	8.7	Ch	269	9.0	Pt	284	10.4	B	263	11.7	Bn	234	6.5	Kd	*022426*		
260	8.9	Wk	269	8.8	Ya	**S PSC**			268	11.7	Bn	235	6.5	Kd	222	8.6	Bl
263	9.0	Ch	271	8.8	B	011208			269	12.3	Pt	235	6.2	En	229	8.6	Bl
264	8.7	Cl	274	8.8	Wk	272	13.8	B				236	6.8	Ch	236	9.0	Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U CET	X CET	W TAU	R DOR	V ORI	T COL
022813	*031401*	042215	*043562*	050003	*051533*
240 8.0 Ch	252 9.5 L	269 11.1 Eb	230 5.5 Ht	237 9.2 Ch	236 7.6 Bl
257 7.9 By	261 9.0 Jo	269 10.9 Pt	234 5.4 Sm	255 11.2 Lg	243 7.7 En
262 7.8 Ch	264 9.2 Cl	286 10.3 B	234 6.0 En	262 10.9 Ch	268 8.3 Bh
269 8.2 Pt	266 9.6 L	301 10.6 Pi	236 5.5 Ht	266 11.4 Lg	S AUR
290 8.3 Gy	269 9.0 Pt	301 10.6 Wl	236 5.4 Bl	269 11.2 Pt	052034
RR CEP	269 9.3 Jo	S TAU	244 5.8 En	273 11.5 Lg	237 9.0 Ch
022980	269 9.4 Kz	042309	R CAE	284 12.6 Lg	257 8.4 Ch
255 13.0 Lg	269 9.6 Eb	219[13.6 Bg	*043738*	286 12.5 B	258 9.4 GC
258 13.1 L	290 10.3 Cl	232 14.9 Bg	216[11.5 Sm	301 12.9 Pi	267 8.0 Pt
267 13.2 L	Y PER	235 14.8 Bf	222 12.0 Bl	301 13.0 Wl	W AUR
269 13.4 Lg	032043	244 14.8 Bf	229 12.0 Bl	T LEP	052036
R TRI	257 9.0 By	286[13.8 B	230 12.0 Ht	*050022*	258 13.4 L
023133	267 8.5 Gb	T CAM	234[12.0 Sm	222 9.0 Bl	267 13.1 L
243 7.3 Ch	269 7.5 Pt	043065	268[11.7 Bh	228 9.2 Bf	S ORI
260 8.4 Sf	R PER	250 12.6 GC	R PIC	229 8.9 Bl	*052404*
261 8.8 Jo	032335	255 13.2 Lg	*044349*	236 8.5 Bl	267 10.0 Pt
261 8.2 Ch	255 12.2 Lg	258 13.1 L	216 9.0 Sm	246 8.2 Bf	271 9.7 B
263 8.1 Wk	266 12.9 Lg	266 13.5 Lg	217 9.4 Ht	261 7.6 B	275 9.4 Al
266 8.2 Wk	269 13.3 Pt	267 13.6 L	222 9.1 Bl	S PIC	289 9.7 Ya
269 8.6 Pt	271 13.5 B	273 13.6 Lg	224 9.0 Ht	*050848*	301 10.1 Pi
269 9.0 Jo	273 13.2 Lg	286 13.8 Lg	226 8.8 Sm	216[12.2 Sm	301 10.0 Wl
269 9.1 Kz	U CAM	288 11.8 Pt	227 8.9 En	227 13.1 Bl	T ORI
269 9.1 Eb	033362	RX TAU	229 8.8 Bl	234[12.9 Sm	*053005a*
272 8.9 B	250 7.6 By	043208	230 8.8 Ht	243[12.2 En	252 9.9 By
288 9.8 Sf	263 7.4 By	269 11.9 Pt	234 8.8 En	R AUR	253 10.1 L
T ARI	V ERI	269 12.4 Kz	234 8.6 Sm	050953	255 9.9 By
024217	*035016*	269 12.2 Eb	236 8.5 Ht	237 8.8 Ch	256 10.1 By
257 8.6 By	252 8.8 Bf	286 11.8 B	236 8.2 Bl	256 8.0 Ch	257 9.8 By
W PER	269 8.8 Bf	289 12.8 Sf	244 7.9 En	269 8.3 Pt	258 10.1 L
024356	T TAU	R RET	V TAU	289 7.9 Al	260 10.0 L
257 10.4 By	041619	*043263*	044617	T PIC	260 10.0 Pt
264 9.5 Cl	252 10.7 By	217 10.3 Ht	237 11.5 Ch	*051247*	261 10.2 B
269 9.4 Pt	255 10.4 By	222 9.6 Bl	255 10.5 Lg	216 8.4 Sm	263 9.9 By
273 9.4 B	256 10.2 By	224 9.8 Ht	255 10.3 GC	217 8.2 Ht	263 9.8 Pt
283 9.4 Cl	257 10.2 By	225 9.6 En	256 10.2 Ch	222 8.0 Bl	264 10.0 L
284 9.5 B	263 10.2 By	228 9.2 Sm	269 10.2 Pt	224 8.2 Ht	266 10.2 L
R HOR	269 10.2 By	229 9.0 Bl	269 10.1 Lg	225 7.9 En	267 10.2 L
025050	272 10.3 By	230 9.0 Ht	269 10.4 Eb	226 8.0 Sm	267 10.1 Pt
217 7.6 Ht	275 10.2 By	234 8.7 Sm	269 10.0 Kz	229 7.9 Bl	268 9.7 Pt
222 6.7 Bl	R TAU	234 9.3 En	275 9.9 GC	230 8.3 Ht	269 9.9 Pt
224 6.6 Ht	042209	236 8.8 Ht	286 10.9 B	234 8.0 En	269 10.1 By
228 6.1 En	219 8.4 Bg	236 8.2 Bl	286 10.7 Lg	234 8.0 Sm	269 10.5 Sp
229 6.3 Bl	228 8.3 Bf	244 8.3 En	U LEP	236 8.0 Ht	271 9.9 Pt
230 6.1 Ht	232 8.8 Bg	X CAM	*045221*	236 8.1 Bl	272 9.9 Pt
233 6.1 Sm	235 8.7 Bf	043274	257 10.9 By	244 8.3 En	272 10.2 By
234 5.6 En	239 9.0 Ch	238 8.5 Ch	R LEP	T COL	272 10.3 Sp
236 6.1 Ht	244 9.1 Bg	260 9.3 Wk	*045514*	*051533*	274 9.7 Pt
236 5.9 Bl	246 9.6 Bf	266 9.5 Wk	237 9.5 Ch	217 8.4 Ht	276 10.5 Pt
242 5.1 En	262 9.6 Ch	274 10.0 Wk	252 8.8 L	222 7.9 Bl	277 10.6 L
T HOR	269 9.6 Kz	288 10.6 Pt	256 9.8 Ch	224 7.8 Ht	282 10.5 Sp
025751	269 9.8 Eb	R DOR	261 8.5 Jo	226 7.8 Sm	286 10.7 B
222 9.1 Bl	269 9.5 Pt	*043562*	263 9.9 Ch	227 7.9 En	288 9.7 Pt
229 8.5 Bl	286 10.0 B	217 5.5 Ht	266 8.6 L	229 7.9 Bl	289 10.0 Pt
236 8.5 Bl	W TAU	222 5.5 Bl	269 8.6 Jo	230 7.5 Ht	289 10.2 Ya
U ARI	042215	224 5.6 Ht	269 8.3 Pt	234 7.5 Sm	301 10.0 Pi
030514	261 10.3 Jo	225 5.8 En	286 9.6 B	234 7.5 En	301 10.5 Wl
232 14.5 Bg	269 10.6 Jo	228 5.5 Sm		236 6.9 Ht	
246[14.5 Bf	269 10.9 Kz	229 5.2 Bl			

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

S CAM
053068
260 9.7 Wk
266 9.4 Wk
267 8.6 Pt
274 8.7 Wk
RR TAU
053326
232 11.3 Bg
255 11.3 GC
RU AUR
053337
267 9.6 Pt
271 9.9 By
U AUR
053531
237 8.6 Ch
262 9.5 Ch
267 9.6 Pt
Y TAU
053920
250 6.5 By
269 6.9 By
282 7.1 Fd
SU TAU
054319
237 9.8 Ch
241 9.8 Ch
246 9.8 Ch
255 9.8 Ch
255 9.4 Lg
256 9.5 Lg
258 9.5 L
260 9.8 L
260 9.5 Lg
260 9.6 Pt
262 9.8 Ch
263 9.6 Pt
264 9.4 Cl
266 9.7 Lg
267 9.6 L
267 9.6 Pt
268 9.9 Pt
269 9.6 Pt
269 9.6 Lg
269 9.7 Sp
269 9.6 Kz
269 9.9 Eb
269 9.5 Bh
270 9.4 L
271 9.2 By
271 9.6 Pt
272 9.6 Pt
272 9.7 Sp
273 9.7 Bh
274 9.8 Bh
274 9.8 Lg
274 9.9 Pt
275 9.8 Lg
276 9.7 Bh

SU TAU
054319
276 9.7 Pt
283 9.3 Cl
283 9.6 Bh
284 9.6 Lg
285 10.0 Bh
285 9.6 Lg
286 9.8 Lg
288 9.9 Bh
288 9.7 Pt
289 9.6 Pt
290 9.5 Cl
290 9.9 Sp
301 9.4 Pi
301 9.5 Wl
S COL
054331
216 10.2 Sm
217 10.2 Ht
222 9.6 Bl
224 9.9 Ht
226 9.9 Sm
227 10.0 En
229 9.5 Bl
230 9.9 Ht
234 8.8 Sm
234 9.7 En
236 10.0 Ht
236 9.0 Bl
243 9.9 En
Z TAU
054615a
228 12.7 Bf
235 12.9 Bf
244 12.9 Bf
246 13.0 Bf
RU TAU
054615c
228 12.9 Bf
235 12.8 Bf
244 12.7 Bf
246 12.7 Bf
R COL
054629
226 12.2 Sm
227 11.7 En
227 12.0 Ht
227 12.0 Bl
230 12.1 Ht
234 11.0 En
234 11.6 Sm
236 11.4 Ht
236 10.8 Bl
243 10.5 En
U ORI
054920a
237 8.8 Ch
255 9.0 Ch
267 10.0 Pt

U ORI
054920a
267 9.0 Fd
269 9.5 Fd
269 9.0 Pn
275 8.9 Al
277 9.2 Pn
282 9.7 Fd
288 10.2 Fd
288 9.1 Al
300 10.8 Pi
300 10.8 Wl
V CAM
054974
238|12.2 Ch
Z AUR
055353
256 10.3 Ch
260 9.6 Pt
263 9.5 Pt
266 10.4 Pt
267 10.3 Pt
268 10.4 Pt
269 10.2 Pt
271 10.0 Pt
272 10.0 Pt
273 10.3 Pt
274 10.4 Pt
276 10.8 Pt
279 10.6 Pt
282 10.8 Al
288 10.9 Pt
289 10.9 Pt
R OCT
055686
216|11.6 Sm
237 12.3 Bl
S LEP
060124
255 6.6 By
269 6.9 By
X AUR
060450
238 8.7 Ch
241 8.6 Ch
244 8.7 Ch
256 8.7 Ch
267 8.8 Pt
272 9.5 Al
282 10.6 Al
V MON
061702
237 7.0 Ch
252 8.4 By
262 8.6 Ch
267 9.1 Pt
269 9.1 By
269 9.1 Kz
269 9.0 Eb

— AUR
062047
253 10.1 L
258 9.7 L
266 9.2 L
Z MON
062808
252 8.7 By
269 8.5 By
R MON
063308
267 10.9 Pt
NOV PIC
063462
217 6.8 Ht
224 6.8 Ht
225 7.0 En
228 6.5 Sm
230 6.7 Ht
233 6.5 Sm
234 6.8 En
236 6.8 Ht
236 6.5 Sm
245 7.0 En
S LYN
063558
236|11.7 Ch
267 14.4 Pt
X GEM
064030
266 9.1 Bn
268 8.7 Bn
269 8.8 Kz
269 9.1 Eb
269 9.1 Sp
273 8.6 Bn
278 8.5 Bn
282 8.6 Bn
282 8.7 Sp
290 8.6 Sp
290 8.6 Bn
300 9.0 Pi
300 9.0 Wl
Y MON
065111
237 11.4 Ch
257 12.5 Ch
266 13.5 Lg
267 12.7 Pt
273 13.5 Lg
286 13.4 Lg
X MON
065208
237 8.0 Ch
252 8.2 L
262 8.2 Ch
266 8.0 L
269 8.2 Kz
269 8.1 Eb

V CMI
070109
236 11.5 Ch
256 11.4 Lg
260 12.1 Ch
266 12.5 Lg
273 13.0 Lg
284 13.4 Lg
287 13.4 B
R GEM
070122a
236 6.5 Ch
247 6.4 Sw
250 6.4 Sw
255 7.0 Ch
261 7.5 Jo
261 7.5 Sw
267 7.5 Al
267 7.0 Pt
269 7.0 Jo
275 7.4 Al
282 7.5 Al
287 7.5 B
300 8.7 Pi
300 8.7 Wl
Z GEM
070122b
267 12.5 Pt
287 12.2 B
TW GEM
070122c
267 7.9 Pt
287 7.8 B
R CMI
070310
252 9.1 L
255 9.4 By
256 9.4 Cb
256 9.7 Lg
266 9.5 Lg
266 9.4 L
269 9.6 Kz
269 9.7 Eb
273 10.3 Lg
284 10.5 Lg
286 9.7 B
R VOL
070772
216|11.8 Sm
227|12.6 Ht
230|12.6 Ht
235|13.4 En
244|13.4 En
L2 PUP
071044
284 3.6 Bh
288 3.9 Bh
RR MON
071201
256 10.5 Lg

RR MON
071201
257 10.3 Ch
266 9.7 Lg
269 9.3 Lg
269 9.2 Kz
269 9.5 Eb
271 9.1 By
273 9.3 Lg
284 9.5 Lg
V GEM
071713
256 13.5 Lg
267 12.3 Pt
272 11.6 B
273 12.0 Lg
286 11.3 Lg
S CMI
072708
241 8.0 Ch
255 8.4 Ch
261 8.3 Jo
267 8.4 Pt
267 8.3 Al
267 8.8 Fd
269 8.5 Jo
269 8.5 Eb
269 8.4 Kz
271 9.0 Fd
274 9.2 Fd
275 8.4 Al
282 8.8 Al
283 9.3 Fd
286 9.5 Fd
286 9.0 B
288 9.0 Al
T CMI
072811
256 11.5 Lg
266 11.2 Lg
269 11.2 Kz
269 11.4 Eb
272 10.9 Sp
273 11.5 Lg
286 10.3 Lg
286 10.3 B
290 10.3 Sp
X PUP
072820a
272 8.1 By
Z PUP
072820b
222 12.4 Bf
228 9.7 Bf
235 9.0 Bf
244 7.8 Bf
246 7.6 Bf
272 7.8 By

Variable Star Observations Received During February, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S Vol	Z Cam	T Cnc	R LMi	Z Car	RS Cen
073173	081473	085120	093934	*101058*	*111661*
222 11.5 Bl	270 12.8 L	238 9.0 Ch	274 10.3 Wk	216 11.4 Sm	229 9.3 Bl
225 11.4 En	V Cnc	256 9.6 By	R Leo	222 11.5 Bl	233 9.5 Sm
227 12.2 Ht	081617	259 9.4 Ch	094211	229 11.6 Bl	236 10.1 Bl
229 11.8 Bl	238 7.5 Ch	267 8.2 Pt	242 6.4 Ch	231 11.4 Sm	X Cen
230 11.8 Ht	242 7.4 Ch	T Pyx	259 7.2 Ch	236 11.4 Sm	*114441*
233 12.2 Sm	259 7.6 Ch	*090031*	260 7.3 Wk	236 11.5 Bl	237 12.6 Bl
235 11.5 En	267 7.8 Pt	227 [u Bl	261 7.3 Jo	245 11.8 En	W Cen
236 12.2 Ht	269 7.9 Kz	V UMa	267 8.6 Fd	W Vel	*115058*
236 12.0 Bl	269 8.0 Eb	090151	267 6.2 Pt	*101153*	222 9.8 Bl
245 12.0 En	RT Hya	258 10.3 L	268 8.6 Fd	216 11.6 Sm	229 9.2 Bl
U CMi	*082405*	270 10.2 L	269 7.5 Jo	222 11.1 Bl	230 9.5 Ht
073508	267 7.4 Pt	287 10.3 B	272 6.6 Al	229 10.8 Bl	237 8.4 Bl
258 12.7 L	286 7.9 B	W Cnc	273 8.7 Fd	233 10.5 Sm	241 8.6 Ht
267 12.6 Pt	R Cha	090425	274 8.3 Wk	236 9.9 Bl	SU Vir
286 12.8 B	*082476*	259 14.0 L	278 8.7 Fd	U Hya	120012
S Gem	226 12.2 Sm	289 13.4 Sf	286 8.8 Fd	*103212*	245 12.3 Ch
073723	227 [12.6 Bl	RW Car	287 7.9 B	220 5.9 Kd	263 12.5 Pt
267 14.6 Pt	234 12.2 Sm	*091868*	288 7.9 Al	248 5.3 Kd	T Vir
271 14.3 B	U Cnc	222 9.1 Bl	289 8.7 Fd	251 4.8 L	*120905*
300 [13.6 Pi	083019	225 8.5 En	Y Hya	261 5.9 Kd	263 14.2 Pt
W Pup	286 [14.1 Lg	229 9.0 Bl	*094622*	267 5.9 Kd	R Crv
074241	X UMa	235 9.7 En	267 6.3 Pt	274 5.7 Kd	*121418*
216 8.1 Sm	083350	236 9.6 Bl	Z Vel	R UMa	222 13.7 Bf
222 8.2 Bl	267 9.4 Pt	245 9.7 En	*094953*	103769	228 13.5 Bf
224 9.2 Ht	273 9.3 B	Y Vel	216 [12.1 Sm	273 12.1 B	235 13.2 Bf
225 8.9 En	RV Hya	*092551*	227 [12.8 Bl	289 11.8 Pt	244 11.9 Bf
226 8.9 Sm	*083409*	227 13.3 Bl	231 [12.1 Sm	V Hya	250 11.7 L
229 9.2 Bl	255 8.1 By	236 13.1 Bl	236 12.8 Ht	*104630*	263 11.1 Pt
230 9.4 Ht	S Hya	R Car	245 [12.1 En	222 8.5 Bl	SS Vir
233 9.4 Sm	084803	*092962*	V Leo	237 8.8 Bl	122001
234 9.5 En	238 8.0 Ch	216 9.4 Sm	095421	244 9.1 Ch	250 7.3 L
236 10.4 Ht	251 7.9 Ch	222 9.0 Bl	238 9.7 Ch	250 8.6 L	T CVn
236 10.0 Bl	259 8.0 Ch	224 9.3 Ht	242 10.4 Ch	262 9.4 Ch	122532
242 11.2 En	263 8.1 Wk	229 8.9 Bl	259 11.7 Ch	267 8.0 Pt	263 10.1 Pt
245 10.8 Sm	267 8.5 Pt	230 8.8 Ht	267 11.7 Pt	RS Hya	288 9.8 Al
T Gem	269 8.3 Kz	231 8.5 Sm	RV Car	*104638*	Y Vir
074323	269 8.6 Eb	235 8.4 En	*095563*	237 [13.7 Bl	122803
267 13.0 Pt	273 8.5 Lg	236 8.4 Sm	227 [13.1 Bl	W Leo	222 12.7 Bf
272 13.8 B	274 8.1 Wk	236 8.8 Ht	S Car	104814	228 12.0 Bf
300 [13.1 Wl	286 9.1 Lg	236 8.6 Bl	*100661*	222 [13.3 Bf	235 11.8 Bf
U Pup	287 8.8 B	242 7.6 En	216 5.5 Sm	235 14.1 Bf	244 11.7 Bf
075612	X Cnc	X Hya	222 5.2 Bl	244 14.5 Bf	250 10.5 L
284 [13.0 B	084917	*093014*	224 5.8 Ht	RS Car	U Cen
286 12.7 Lg	256 6.7 By	222 11.2 Bf	225 6.0 En	*110361*	*122854*
R Cnc	T Hya	228 11.5 Bf	229 6.3 Bl	216 [12.1 Sm	222 8.3 Bl
081112	*085008*	235 11.6 Bf	230 6.0 Ht	233 [12.3 Sm	229 8.7 Bl
238 10.6 Ch	238 7.2 Ch	238 11.6 Ch	231 6.0 Sm	242 [12.3 En	237 9.2 Bl
242 10.1 Ch	242 7.4 Ch	244 12.0 Bf	235 6.1 En	S Leo	T UMa
259 9.6 Ch	250 7.5 L	267 13.0 Pt	236 6.2 Bl	110506	123160
263 9.8 Wk	259 7.8 Ch	287 13.0 B	236 6.5 Ht	245 12.0 Ch	263 12.8 Pt
267 9.4 Pt	266 8.3 L	Y Dra	236 6.3 Sm	RY Car	R Vir
269 9.3 Kz	267 8.6 Pt	093178	242 6.5 En	*111561*	123307
269 9.4 Eb	269 8.2 Kz	263 9.3 Wk	245 6.8 Sm	227 [13.5 Bl	263 7.1 Pt
273 9.4 B	269 8.5 Eb	274 8.6 Wk	U UMa	237 [13.5 Bl	RS UMa
274 9.9 Wk	273 9.0 Lg	R LMi	100860	RS Cen	123459
Z Cam	286 9.3 Lg	093934	256 6.5 By	*111661*	222 13.0 Bf
081473		260 10.8 Wk		216 8.9 Sm	228 13.0 Bf
259 11.4 L		267 11.7 Pt		222 9.1 Bl	235 12.2 Bf

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS UMA	T CEN	S LIB	R SER	S OPH	RS OPH
123459	*133633*	*151520*	154615	*162816*	174406
244 10.2 Bf	248 6.4 Kd	243 9.8 Ch	263 5.6 Pt	258 11.0 L	271 11.2 Pt
261 10.1 Jo	266 7.1 Kd	258 9.5 L	V CRB	W HER	RY HER
262 9.6 Ch	RT CEN	263 8.6 Pt	154639	163137	175519
263 9.4 Pt	*134236*	S SER	263 8.6 Pt	245 11.6 Ch	271 9.0 Pt
269 9.9 Jo	237 9.4 Bl	151714	RR LIB	271 12.3 Pt	R PAV
274 10.2 Fd	R CVN	258 13.5 L	*155018*	R DRA	*180363*
279 9.3 Al	134440	S CRB	243 9.8 Ch	163266	216 7.8 Sm
288 9.0 Al	263 11.4 Pt	151731	258 11.3 L	271 11.7 Pt	217 8.1 Ht
S UMA	RX CEN	245 8.2 Ch	RZ Sco	274 10.3 Fd	224 8.1 Ht
123961	*134536*	263 8.6 Pt	*155823*	282 10.2 Fd	226 8.3 Sm
257 11.0 Kl	237|13.1 Bl	267 9.0 Fd	263 11.7 Pt	RR OPH	T HER
262 10.6 Ch	T APS	274 9.2 Fd	Z Sco	*164319*	180531
263 10.8 Pt	*134677*	288 9.7 Fd	*160021*	258|11.2 L	258 12.9 L
274 11.7 Fd	222 11.2 Bl	RS LIB	258 10.9 L	271 12.5 Pt	271 13.3 Pt
279 11.0 Al	229 12.0 Bl	*151822*	R HER	S HER	W DRA
288 11.5 Al	236 12.5 Sm	237 10.2 Bl	160118	164715	180565
RU VIR	237 12.1 Bl	258 11.2 L	243|10.7 Ch	271 8.5 Pt	271 12.0 Pt
124204	RR VIR	RU LIB	267|11.0 Fd	RS SCO	NOV OPH
263 12.1 Pt	*135908*	*152714*	U SER	*164844*	180911
U VIR	263 13.5 Pt	258 11.3 L	160210	237 8.5 Bl	271|13.0 Pt
124606	RU HYA	R NOR	263 11.5 Pt	SS OPH	TV HER
263 11.0 Pt	*140528*	*152849*	SX HER	*165202*	181031
274 9.8 Wk	237 8.6 Bl	237 8.6 Bl	160325	271 9.4 Pt	258 14.0 L
288 9.4 Al	R CEN	S UMI	258 8.5 L	RV HER	RY OPH
U OCT	*140959*	153378	263 8.0 Pt	165631	181103
131283	222 7.2 Bl	261 8.3 Jo	266 7.9 Pt	271 10.8 Pt	271 13.1 Pt
222 7.5 Bl	230 7.5 Ht	263 8.6 Pt	267 7.9 Pt	R OPH	W LYR
224 7.5 Ht	237 7.9 Bl	269 8.5 Jo	268 7.9 Pt	*170215*	181136
228 7.8 En	U UMI	R CRB	271 7.9 Pt	271 9.4 Pt	271 13.1 Pt
229 8.3 Bl	141567	154428	273 7.9 Pt	Z OPH	T SER
230 8.2 Ht	244 9.5 Ch	220 6.1 Kd	274 8.0 Pt	171401	182306
234 8.2 Sm	263 10.6 Pt	243 6.1 Ch	276 7.9 Pt	271 9.3 Pt	271 12.5 Pt
235 8.0 En	S Boo	248 6.0 Kd	279 8.0 Pt	278 9.5 Sp	X OPH
236 8.6 Ht	141954	250 6.0 L	RU HER	RS HER	183308
237 8.4 Bl	250 10.5 L	258 6.1 Pt	160625a	171723	258 8.4 L
W VIR	263 11.1 Pt	261 6.1 Kd	263 13.8 Pt	271 12.6 Pt	271 8.3 Pt
132002	V Boo	263 6.0 Pt	R Sco	S OCT	R SCT
272 10.0 Sp	142539a	264 5.8 Sp	*161122a*	*172486*	*184205*
290 9.5 Sp	263 7.9 Pt	266 6.1 Kd	244 10.9 Bf	216 10.0 Sm	207 6.0 Kd
V VIR	267 7.1 Fd	266 6.1 Pt	S Sco	222 9.7 Bl	209 6.2 Kd
132202	274 7.8 Fd	267 6.1 Pt	*161122b*	224 10.1 Ht	212 6.3 Kd
272 9.6 Sp	288 9.3 Fd	267 6.1 Fd	271 11.0 Pt	228 9.8 Bl	227 5.9 Kd
278 10.0 Sp	R Boo	268 6.1 Pt	W CRB	228 10.0 En	231 5.6 Kd
R HYA	143227	271 6.0 Pt	161138	230 10.3 Ht	234 5.6 Kd
132422	263 7.5 Pt	272 5.9 Sp	267|11.0 Fd	233 10.4 Sm	258 5.0 L
237 7.2 Bl	Y LUP	273 6.1 Pt	272|11.2 Sp	235 10.7 En	266 5.3 Kd
258 7.6 L	*145254*	274 6.1 Pt	V OPH	236 9.9 Bl	266 6.0 Pt
263 8.0 Pt	237|13.7 Bl	274 6.5 Fd	*162112*	236 10.6 Ht	271 5.5 Pt
S VIR	S APS	274 6.0 Bh	271 9.6 Pt	RU OPH	272 5.5 Sp
132706	*145071*	276 6.1 Pt	U HER	172809	273 5.4 Pt
263 10.9 Pt	222 10.1 Bl	278 5.9 Sp	162119	271 9.0 Pt	276 5.5 Pt
RV CEN	229 10.5 Bl	279 6.0 Pt	267 10.0 Fd	RU Sco	278 5.4 Sp
133155	236 10.0 Bl	281 6.0 Sp	271 10.2 Pt	*173543*	279 5.6 Pt
222 8.2 Bl	Y LIB	284 6.3 Bh	274 10.1 Fd	237 10.0 Bl	282 5.5 Sp
237 8.4 Bl	*150605*	288 6.4 Fd	SS HER	W PAV	284 5.2 Bh
T CEN	258 8.7 L	288 6.0 Pt	162807	*174162*	285 5.7 Lg
133633	263 8.4 Pt	289 6.1 Pt	258 8.7 L	227|12.1 Bl	287 5.7 Lg
237 6.1 Bl			271 9.4 Pt		

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Nov AQL	T PAV	RW AQL	U MIC	U CAP	T CAP
184300	*193972*	200715b	*202240*	*204215*	*211615*
266 11.2 Pt	216 9.8 Sm	260 9.1 Pt	222 11.9 Bl	227[12.2 Bl	227 9.1 Bl
273 11.3 Pt	217 10.9 Ht	R TEL	229 11.7 Bl	T AQR	238 9.1 Ch
279 11.4 Pt	222 10.2 Bl	*200747*	236 11.7 Bl	*204405*	S MIC
RX LYR	224 9.3 Ht	222 11.3 Bl	RU CAP	238 10.0 Ch	*212030*
185032	225 8.9 En	229 11.2 Bl	*202622*	RZ CYG	216 8.9 Sm
214 12.6 Ch	226 9.2 Sm	236 11.3 Bl	231[14.1 Bf	204846	222 9.3 Bl
226 12.8 Ch	228 9.4 Bi	W CAP	Z DEL	246 11.7 GC	226 9.3 Sm
S CRA	230 9.2 Ht	*200822*	202817	271 13.0 Pt	229 9.2 Bl
185437a	234 8.6 Sm	227[12.5 Bl	263 9.1 Pt	S IND	234 9.3 Sm
227 12.0 Bl	234 8.9 En	Z AQL	SZ CYG	*204954*	236 9.2 Bl
R CRA	236 8.9 Ht	*200006*	202946	227[13.5 Bl	Y CAP
185537a	236 8.6 Bl	218 9.7 Bg	258 9.2 Pt	R VUL	*212814*
227[12.0 Bl	RT CYG	*222* 9.2 Bg	260 9.4 Pt	205923	227[12.6 Bl
T CRA	194048	*229* 8.8 Bg	263 9.2 Pt	240 8.3 Ch	238[10.6 Ch
185537b	237 9.1 Ch	231 8.8 Bf	266 9.0 Pt	V CAP	W CYG
227[12.0 Bl	260 11.0 Pt	RS CYG	267 8.8 Pt	*210124*	213244
RT LYR	263 10.1 Wk	200938	268 9.2 Pt	222 10.1 Bl	207 6.5 Kd
185737	TU CYG	237 7.5 Ch	269 9.2 Pt	229 10.4 Bl	208 6.6 Kd
240 10.0 Ch	194348	240 7.6 Ch	271 9.2 Pt	X CAP	210 6.6 Kd
X LYR	237 10.4 Ch	241 8.0 Ch	272 9.2 Pt	*210221*	213 6.5 Kd
190926	260 10.7 Pt	242 7.8 Ch	273 9.5 Pt	227 11.1 Bl	216 6.4 Kd
271 8.9 Pt	χ CYG	243 7.8 Ch	276 9.6 Pt	X CEP	225 6.6 Kd
RS LYR	194632	245 7.8 Ch	279 9.3 Pt	210382	228 6.6 Kd
190933a	260 11.0 Pt	246 7.8 Ch	288 9.5 Pt	271[13.2 GC	234 6.2 Kd
240[11.8 Ch	*272* 10.3 Sp	259 7.8 L	289 9.6 Pt	RS AQR	235 6.2 Kd
RU LYR	278 9.8 Sp	260 7.6 Pt	ST CYG	*210504*	238 6.4 Kd
190941	RR SGR	263 9.0 Ch	202954	259 11.3 L	240 6.6 Kd
271 11.9 Pt	*194929*	269 8.9 Sp	263 13.1 Pt	Z CAP	259 6.4 L
U DRA	*227* 12.6 Bl	270 8.7 L	V VEL	*210516*	261 6.7 Kd
190967	RU SGR	278 9.2 Sp	203226	222 14.5 Bg	264 6.7 Kd
240 10.9 Ch	*195142*	R DEL	267 9.4 Pt	231 13.9 Bf	266 6.6 Kd
269 9.2 Kz	217 12.0 Ht	201008	R MIC	236 13.5 Bg	270 6.7 Kd
269 9.4 Eb	222[12.1 Bl	241 8.6 Ch	*203420*	246 12.5 Bf	S CEP
271 9.6 Pt	226[12.1 Sm	259 9.4 L	227[12.8 Bl	R EQU	213678
RY SGR	NOV CYG	RT CAP	S DEL	210812	261 8.9 Ch
191033	195553	*201121*	203816	222 9.4 Bg	261 8.8 Jo
224 6.0 En	260[12.4 Pt	212 7.6 Kd	267 11.2 Pt	229 9.2 Bg	269 8.4 Jo
227 6.0 Bl	271[12.2 Pt	SX CYG	V CYG	232 9.4 Bg	*272* 8.6 B
SW SGR	279[12.2 Pt	201130	203847	236 9.1 Bg	288 8.6 Pt
191331	289[12.2 Pt	260 10.6 Pt	271 13.3 Pt	239 9.3 Bf	RU CYG
227[12.1 Bl	Z CYG	RT SGR	Y AQR	246 9.5 Bf	213753
TZ CYG	195849	*201139*	*203005*	T CEP	237 8.8 Ch
191350	260 9.3 Pt	222 10.2 Bl	218 11.7 Bg	210868	256 8.8 Ch
272 10.5 Sp	S TEL	229 10.2 Bl	222 11.9 Bg	241 8.6 Ch	262 8.4 Wk
273 10.5 Pt	*195855*	236 9.8 Bl	231 12.0 Bf	255 9.0 Ch	269 8.2 Pt
278 11.0 Sp	227 13.2 Bl	WX CYG	236 12.5 Bg	261 8.6 Jo	276 8.3 Wk
U LYR	SY AQL	201437b	246 12.6 Bf	261 9.6 Sw	RV CYG
191637	200212	237 10.6 Ch	V AOR	262 9.7 Wk	213937
273 8.6 Pt	259 10.4 L	242 10.6 Ch	204102	263 9.5 Sw	250 6.6 By
RT AQL	260 10.3 Pt	259 11.1 L	241 8.7 Ch	267 9.8 Fd	259 6.7 L
193311	SV CYG	260 10.9 Pt	W AQR	269 9.0 Pn	263 6.6 By
241 11.0 Ch	200647	U CYG	*204104*	269 8.8 Jo	269 6.3 Pt
R CYG	252 9.4 By	201647	218 13.4 Bg	272 9.5 B	RR PEG
193449	S AQL	252 10.2 By	222 13.5 Bg	273 10.1 Fd	214024
260 10.2 Pt	200715a	263 9.0 Pt	231 13.6 Bf	274 9.7 Wk	269 10.2 Pt
263 9.7 Wk	260 9.0 Pt	269 9.8 Sp	236 13.2 Bg	277 9.0 Pn	R GRU
276 9.4 Wk			246 13.7 Bf	278 10.0 Fd	*214247*
				289 10.1 Fd	217[12.4 Ht

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R GRU	RS PEG	T TUC	V CAS	ST AND	RR CAS
214247	220714	*223162*	230759	233335	235053
227[13.7 Bl	254 13.4 Lg	217 10.7 Ht	269 11.0 Ya	276 9.9 Wk	287 13.4 B
230[12.9 Ht	X AQR	224 11.3 Ht	275 12.6 B	277 10.8 Al	290 13.2 Bn
233[12.4 Sm	*221321*	227 11.1 En	W PEG	284 10.7 Lg	V CET
242[12.9 En	222 9.3 Bg	228 11.3 Sm	231425	288 9.8 Gb	*235209*
RT PEG	231 9.4 Bf	230 11.7 Ht	240 10.9 Ch	R AQR	222 9.0 Bl
215934	236 9.6 Bg	234 11.8 Sm	256 10.8 Lg	*233815*	229 9.3 Bl
240 11.3 Ch	246 9.9 Bf	234 12.0 En	260 11.3 Kl	222 10.2 Bl	236 8.9 Bl
261 11.4 Ch	T GRU	236 12.3 Ht	269 11.3 Lg	224 10.3 Ht	254 9.3 Lg
RZ PEG	*221938*	243 12.3 En	271 11.4 Kl	225 10.2 En	259 9.4 L
220133b	216 11.3 Sm	R LAC	273 11.5 Kl	229 10.0 Bl	269 10.3 Lg
269 11.7 Pt	225 10.7 En	223841	S PEG	230 10.4 Ht	R TUC
T PEG	226 10.8 Sm	259 14.0 L	231508	230 10.5 Bf	*235265*
220412	233 10.1 Sm	U LAC	289 12.6 Pt	233 10.1 Sm	216[12.6 Sm
259 12.1 L	234 10.6 En	224354	V PHE	233 10.3 Bf	228[12.9 En
261[11.5 Ch	242 10.4 En	250 8.4 By	*232746*	234 9.7 En	233[12.9 Sm
Y PEG	245 9.8 Sm	263 8.0 By	224[12.7 Ht	235 10.3 Bf	242[12.9 En
220613	S GRU	RW PEG	230[13.2 Ht	236 10.3 Ht	R CAS
218 11.5 Bg	*221048*	225914	233[13.2 Sm	236 9.7 Bl	235350
222 11.1 Bg	217[12.8 Ht	218 11.1 Bg	234[13.2 En	237 10.3 Bf	255 9.7 Ch
229 10.9 Bg	226 12.8 Sm	222 11.0 Bg	242[13.2 En	240 10.1 Ch	287 10.2 B
231 10.9 Bf	230 13.0 Ht	229 11.0 Bg	Z AND	241 10.4 Ht	Z PEG
236 10.9 Bg	233 12.6 Sm	231 10.9 Bf	232848	242 10.2 Bf	235525
239 10.9 Bf	234 12.8 En	236 10.4 Bg	239 10.4 Ch	254 11.1 Lg	269 12.8 Pt
246 11.0 Bf	236 12.8 Ht	239 10.5 Bf	269 10.0 Pt	256 9.5 Ch	W CET
254 11.6 Lg	242 12.6 En	246 10.2 Bf	ST AND	259 9.6 L	*235715*
RS PEG	RV PEG	272 9.5 Sp	233335	269 9.7 Lg	254 9.1 Lg
220714	222129	289 9.5 Pt	239 10.9 Ch	RS AND	269 9.5 Lg
218 13.0 Bg	269 9.9 Sp	290 10.2 Sp	255 10.8 Ch	235048	Y CAS
222 13.1 Bg	S LAC	R PEG	256 11.1 Lg	250 9.4 By	*235855*
229 12.8 Bg	222439	230110	262 10.9 Wk	263 9.4 By	269[10.6 Ya
231 13.3 Bf	259 13.9 L	256 13.6 Lg	269 10.9 Pt	RR CAS	287 12.1 B
236 12.6 Bg	R IND	V CAS	269 10.8 Lg	235053	SV AND
239 12.8 Bf	*222867*	230759	274 10.8 Lg	263 11.6 Bn	235939
246 12.7 Bf	227 13.5 Bl	269 12.5 Pt	276 10.9 Al	268 11.9 Bn	269 11.9 Pt

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D.	Est.Obs.	J.D.	Est.Obs.	Star J.D.	Est.Obs.	J.D.	Est.Obs.
005840 RX ANDROMEDAE—				060547 SS AURIGAE—			
5260.6	10.8 Pt	5271.6	[12.4 Pt	5260.3	[13.9 L	5273.8	[14.1 Lg
5263.6	11.7 Pt	5272.6	11.3 Pt	5261.6	[13.5 Lg	5274.8	[14.1 Lg
5267.6	13.2 Pt	5288.6	11.1 Pt	5262.1	[11.6 Ch	5275.7	[14.1 Lg
5268.8	[11.7 Pt	5289.6	11.1 Pt	5263.6	[12.6 Pt	5276.7	[10.8 Pt
5269.6	[12.4 Pt			5264.3	[14.5 L	5277.2	[12.4 L
060547 SS AURIGAE—				5266.3	[14.5 L	5279.9	[12.4 Pt
5222.4	[14.3 Bf	5239.2	14.1 Bf	5267.3	14.1 L	5283.5	[12.4 Cl
5228.4	12.0 Bf	5240.1	[11.6 Ch	5268.8	[12.6 Pt	5284.6	[14.1 Lg
5229.1	10.8 Bf	5241.1	[11.6 Ch	5269.5	[12.4 Bh	5285.6	[14.1 Lg
5229.1	11.1 Bg	5242.1	[11.6 Ch	5269.6	[14.1 Lg	5286.6	[14.1 Lg
5230.1	10.8 Bf	5243.1	[11.6 Ch	5270.2	[12.4 L	5288.6	[12.6 Pt
5231.2	11.1 Bf	5244.4	[14.5 Bf	5271.6	[12.6 Pt	5289.6	[12.6 Pt
5232.1	11.0 Bg	5245.1	[11.6 Ch	5272.6	[12.4 Pt	5290.5	[12.4 Cl
5233.1	11.1 Bf	5246.4	14.7 Bf	074922 U GEMINORUM—			
5235.1	11.7 Bf	5255.6	[13.5 Lg	5222.4	[13.7 Bf	5239.1	[12.4 Ch
5235.1	11.3 Bg	5256.8	[13.3 Lg	5228.4	14.0 Bf	5240.1	[12.4 Ch
5236.1	12.4 Bg	5257.1	[13.3 Ch	5235.4	14.3 Bf	5241.1	[12.4 Ch
5237.1	[11.6 Ch	5258.7	[13.9 L	5236.1	[12.4 Ch	5242.2	[12.4 Ch
5238.1	[11.6 Ch	5259.3	14.7 L	5238.1	[12.4 Ch	5243.1	[12.4 Ch

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
074922 U GEMINORUM—						
	5244.2	12.4	Ch	5272.6	11.2	Pt
	5244.4	14.7	Bf	5272.6	14.0	B
	5245.1	12.4	Ch	5273.7	14.0	Lg
	5246.2	14.7	Bf	5274.7	13.9	Lg
	5247.6	12.3	GC	5275.7	13.8	Lg
	5255.7	13.1	GC	5276.7	11.2	Pt
	5256.6	13.1	GC	5283.5	9.6	Cl
	5257.1	13.7	Ch	5283.5	9.1	Bh
	5258.7	13.7	GC	5284.5	9.7	B
	5266.7	14.0	Lg	5284.6	9.1	Bh
	5267.4	13.7	L	5284.7	9.5	Lg
	5268.8	12.4	Pt	5285.5	9.1	Bh
	5269.7	14.0	Lg	5285.7	9.4	Lg
	5271.6	14.0	B	5286.5	9.5	B
074922 U GEMINORUM—						
	5259.2	12.4	Ch	5286.7	9.7	Lg
	5260.1	14.1	Ch	5287.6	9.7	B
	5260.3	13.7	L	5288.6	9.8	B
	5261.2	12.4	Ch	5288.6	9.6	Bh
	5262.2	12.4	Ch	5288.6	9.1	Pt
	5263.7	12.8	GC	5289.6	9.5	Pt
	5264.3	14.1	L	5290.5	10.7	Sp
	5265.7	13.8	GC	5300.6	13.7	Pi
213843 SS CYGNI—						
	5236.0	8.9	Ch	5245.0	11.6	Ch
	5237.1	9.0	Ch	5246.0	11.6	Ch
	5238.0	9.0	Ch	5247.6	11.8	GC
	5239.1	9.3	Ch	5250.3	12.0	L
	5240.0	10.0	Ch	5250.6	11.7	By
	5241.0	10.8	Ch	5252.2	11.8	L
	5242.0	11.3	Ch	5252.5	11.8	GC
	5243.0	11.6	Ch	5254.6	11.7	Lg
	5244.0	11.6	Ch	5255.0	12.0	Ch

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—						
	5255.5	11.9	GC	5269.6	9.0	Pt
	5255.6	11.9	Lg	5269.6	8.4	Lg
	5255.6	11.9	By	5269.6	8.8	Kz
	5256.1	12.0	Ch	5269.6	8.8	Eb
	5256.6	12.0	By	5270.2	8.8	L
	5256.6	11.9	Lg	5271.3	8.0	Kl
	5257.1	12.0	Ch	5271.5	8.9	By
	5257.5	11.7	By	5271.5	8.6	B
	5257.6	11.7	GC	5271.6	8.8	Lg
	5258.9	11.7	Pt	5271.6	9.0	Pt
	5259.0	11.9	Ch	5272.5	8.6	By
	5259.2	12.2	L	5272.5	8.2	B
	5260.3	12.2	L	5272.5	8.4	Sp
	5260.6	11.6	GC	5272.6	8.9	Pt
	5260.6	11.6	Pt	5273.2	8.0	Kl
	5260.6	11.9	Lg	5273.6	8.4	Bh
	5261.0	12.1	Ch	5273.6	8.9	Lg
	5261.6	11.9	Lg	5273.9	8.9	Pt
	5262.1	12.1	Ch	5274.6	8.8	Lg
	5263.0	12.1	Ch	5274.6	8.6	Bh
	5263.5	11.9	By	5275.5	8.6	GC
	5263.6	11.7	Pt	5275.6	8.8	Lg
	5264.3	12.1	L	5275.5	8.9	By
	5266.3	9.3	L	5276.8	8.8	Wk
	5266.6	10.6	Lg	5276.9	8.8	Pt
	5266.9	8.3	Pt	5277.2	9.0	L
	5267.2	8.7	L	5278.5	9.5	Fd
	5267.4	8.8	Pn	5279.9	9.4	Pt
	5267.6	8.8	Pt	5283.6	12.0	Bh
	5268.5	9.7	GC	5284.6	11.8	Lg
	5269.4	8.7	Pn	5288.6	11.7	Pt
	5268.9	9.0	Pt	5289.6	11.7	Pt
	5269.5	8.6	Bh	5289.5	8.6	Sp
	5269.5	9.0	By			

MONTHLY SUMMARY.

Observer	Initial	Vars.	Observations
Allen, P. R.	Al	17	29
Baldwin	Bl	85	164
Bappu	Bf	30	91
Barry	By	19	39
Bhaskaran	Bg	18	50
Bouton	B	56	65
Brown	Bn	3	13
Bunch	Bh	9	23
Chandra	Ch	88	190
Clement	Cl	6	6
Ebert	Eb	20	20
Enser	En	36	85
Ford	Fd	17	45
Gaebler	Gb	3	3
Gregory	Gy	2	3
Houghton	Ht	29	86
Jones	Jo	13	26
Kanda	Kd	10	74
Kohl	Kl	3	5
Kurtz	Kz	20	20
Lacchini	L	59	98
Logan	Lg	32	112
Peltier	Pt	162	271
Pickering	Pi	10	10
Prentice	Pn	5	7
Smith, F. W.	Sf	4	5
Smith, W. H.	Sm	41	86
Spears	Sp	19	39
Swanson	Sw	3	11
Waldo	Wl	9	9
Watkins	Wk	22	44
Yalden	Ya	11	11
Georgetown	GC	12	25
Coll. Obs.	—	—	—
Totals	33	353	1789

last report. The former was at maximum early in February, and from the abundance of observations received, the wide type of curve is clearly indicated, the variable remaining above magnitude ten for at least eight days. SS Aurigae was at maximum just after U Geminorum had faded to minimum, but the observations, received to date, are too meagre to ascertain the type of curve. The other special stars, although doing nothing particularly interesting, have been very carefully observed, thanks to the wide distribution of our observing stations.

LEON CAMPBELL, Recording Secretary.

March 8, 1928.

METEOR NOTES.

By CHARLES P. OLIVIER.

The meteors of last June, probably connected with the Pons-Winnecke Comet, were discussed some months ago in these Notes, but now more data are at hand. In a report, received last summer, on the fireball of June 28, C. C. Williford of the U. S. Weather Bureau Office, Chattanooga, Tennessee, made the following note: "Numerous meteors were observed on the evenings of June 26, 27, 28, and 29. They seemed to originate in Lyra . . . or about where the Comet was seen . . ."

A very belated report from K. A. Shepherd of Winston-Salem, North Carolina, tells of a remarkable shower seen there June 23, 1927, from 11 to 15 hours. He also gave the name of R. L. Strelitz of the same city, who with others had been observing with him. The latter was immediately written to, and he confirmed the general details of Shepherd's report. Both will be partly quoted. Shepherd says: " . . They fell in practically every quarter of the sky, in such rapid succession that it was impossible to find their radiant or plot their paths with reasonable accuracy. . . . Hourly number at 11:00 P.M. about 60; at 12:00 P.M. over 100; steady decrease thereafter. About 30 per hour at 3:00 A.M. . . . Average duration of trails was 2 to 3 seconds, though some of the large meteors . . . lasted 5 seconds . . . The meteors moved directly to the south, this being true of every quarter of the sky . . . This . . . direction of the motion . . . was noticed by many of my companions . . . Around 2:00 A.M. . . . general direction was slowly changing to the southwest . . ."

R. L. Strelitz, in a letter of February 20, 1928, writes: "As to the number of meteors we saw, I am totally lost to give any figures. They came thick and fast. Most of them were very bright. Some of them were so bright that we listened 5 or 6 minutes for sounds, but I was unable to hear any. I did notice that, with few exceptions, the meteors . . . shot due west . . . we saw only a fraction of the meteors . . ." (Due to houses.)

It is due these observers to say that neither had had any appreciable experience in meteor observing, but this cannot discount in the least their estimates of numbers, which is the important point here. In view of these three independent reports from two states, there is nothing to do but realize that during the latter part of June, 1927, on certain dates, some localities were favored far more than others in the numbers of meteors which appeared. It is too bad that the radiant point was not determined by some trained observer, at each of these stations, but unfortunately very few of them exist. One function of the A.M.S. is to train persons so that when such a rare opportunity does come, they can make the most of it by observing in a scientific manner. It is certain that others saw these

meteors, and it would help in the drawing of general conclusions if some of these persons could be reached.

All of our members are urged, with the return of spring, to throw off the inertia that cold weather brings to most of them. The Lyrids, April 18 to 23, probable maximum April 21, and the Eta Aquarids, May 1 to 8, probable maximum about May 4, both deserve special attention. The writer is most desirous for accurate observations on the latter, which are connected with Halley's Comet. In this case observations should run from 2:00 A.M. to dawn, the radiant rising after midnight.

Gnomonic meteor maps for the southern hemisphere have at last been received, and sets have already been mailed to our observers there, who so far have been greatly handicapped in their work from not having them. We also now have standard record sheets for our observers, which may be had on request, as well as the new form for telescopic meteors. These last are principally for those of the A.A.V.S.O. who so kindly aid us in this matter.

Leander McCormick Observatory, University of Virginia, 1928 March 16.

COMET NOTES.

By G. VAN BIESBROECK.

COMET 1928 *a* (REINMUTH), to which a brief reference was made last month, has now been observed in various places. The discoverer, after finding the object on Heidelberg plates taken on February 22, located it near the edge of an earlier plate taken by himself on January 29. In February the brightness was estimated between 12^M and $13^M.5$ by various observers. From my records the brightness has slowly decreased during the month of March and a broad tail about two minutes long has been noticed in the second quadrant on several occasions.

From the available observations, preliminary orbits have been computed with the result that we have here another short period comet. The elements are as follows:

	Berman and Whipple (Berkeley) U.T.		A. C. D. Crommelin U.T.		M. Ebell U.T.		Comet 1916 I H. M. Jeffers G.M.T.	
T =	1928 Feb. 13.87		1928 Feb. 1.650		1928 Feb. 2.417		1916 Jan. 30.917	
ω =	16° 0′		9° 26′6		9° 47′98		354° 48′0	
Ω =	124 16	1928.0	124 53.2	1928.0	124 53.96	1928.0	113 54.2	1916.0
i =	7 18		8 0.3		8 0.75		15 31.7	
e =	0.4742		0.5005		0.5010		0.5465	
q =	1.792		1.856		1.858		1.558	
P =	6.29 years		7.164 years		7.183 years		6.367 years	

A. O. Leuschner, in communicating the elements obtained at Berkeley, states that the comet is probably identical with comet 1916 I (Taylor). A. C. Crommelin finds a slight resemblance to the orbit of comet 1894 I (Denning) but he does not think that identity is possible.

Leuschner's assumption seems to be well justified. The definitive elements obtained by H. M. Jeffers for comet 1916 I have been given along with the recent computations so as to show the great analogy between the two orbits. It will be remembered that comet 1916 I was found at Capetown by Mr. C. J. Taylor on November 25, 1915, and was followed until May 27, 1916, by Barnard, and that it showed a striking case of fission: on February 9, that is about 9 days after the

perihelion passage, Barnard described it as two perfectly distinct comets whose nebulosity mingled. For nearly two months the two parts were followed, and there were considerable changes in their relative brightness and sharpness.

Jeffers' careful computations led to a prediction of a return in June, 1922, but the conditions of visibility were unfavorable, and the object was not seen again. He further pointed out that the comet made a close approach to Jupiter in 1925, at which time it would have stayed for three months within 0.3 astronomical units of the large planet. It is premature to decide if the resulting perturbations would account for a change in the elements that would make them identical with those of comet Reinmuth. This can only be settled by careful computations when accurate elements have been established for the present apparition. In view of the probable identity of the two comets, and of the curious physical changes that happened in 1916, the present object deserves close attention. It is, however, quite faint and slowly losing in brightness, and a photographic search by the writer has not shown any evidence of duplicity.

Further observations on the previously announced comets have been continued: The Cape Observatory has published four photographic measures of COMET 1927 *k* (SKJELLERUP) from February 10 to 13. The comet appeared as a large diffuse image with a faint nucleus. The positions are in good agreement with the ephemeris computed at Berkeley. No magnitude is stated for the brightness of the comet at this late date, but exposures as long as 30 minutes with the astrographic telescope seemed to be required for obtaining well measurable images.

COMET 1927 *d* (STEARNS) has now been followed for more than a year. Its brightness is now about $13^{M}.5$ (March 22). It will be under observation for a long time yet.

The last observation of COMET 1927 *j* (SCHWASSMANN-WACHMANN), secured by the writer, was on February 24. Later measures may have been obtained elsewhere during the month of March, but now the object is lost in the evening sky.

Williams Bay, Wisconsin, March 23, 1928.

SUPPLEMENTARY NOTE. After the above notes were in type, revised elements and an ephemeris of COMET 1928 *a* (REINMUTH) were received direct from Professor A. O. Leuschner. The revised elements also were computed by Berman and Whipple. They are based upon the three observations, 1928 Jan. 29 and Feb. 2, by Reinmuth at Königstuhl and March 15, by Crawford at Lick.

The revised elements are:

$$\left.\begin{aligned} T &= 1928\ \text{Jan.}\ 31.07272 \\ \omega &= 8^\circ\ 39'\ 05''.3 \\ \Omega &= 124\ \ 56\ \ 05.8 \\ i &= 8\ \ 03\ \ 45.1 \end{aligned}\right\} 1928.0$$

$$e = 0.502786$$
$$q = 1.86036$$
$$P = 7.23732 \text{ years}$$

EPHEMERIS

1928 U.T.	α (1928.0) h m s	δ (1928.0) ° ′
March 19.0	9 18 02	+23 34.4
March 27.0	9 22 53	+23 33.2
April 4.0	9 29 31	+23 16.4
April 12.0	9 37 41	+22 45.8
April 20.0	9 47 07	+22 03.1
April 28.0	9 57 36	+21 10.0

GENERAL NOTES.

Dr. W. H. Wright, of the Lick Observatory, has been appointed by the council of the Royal Astronomical Society as the George Darwin Lecturer for this year.

Professor Antonio Abetti, director of the Astrophysical Observatory of the Royal University of Florence from 1894 to 1922, died at his home in Florence on February 20, in his eighty-second year. Professor Abetti will be missed in the circle of astronomers the world over, as he was a distinguished member of that group for many years.

Dr. W. J. Luyten, assistant professor of astronomy at the Harvard College Observatory, has recently been awarded a Guggenheim Fellowship, as announced by the John Simon Guggenheim Foundation. The award will enable Dr. Luyten to go to the Boyden Station of the Harvard Observatory at Bloemfontein, South Africa, where for one year he will undertake to photograph the southern sky with the Bruce telescope in order to accumulate new plates for comparison with similar plates made between 1896 and 1905 in his systematic study of large proper motions. A new mounting for the Bruce telescope has just been completed by J. W. Fecker at Pittsburgh.

The Funeral of Prof. H. A. Lorentz, which took place at Haarlem on Thursday, February 10, afforded a striking tribute to the honor and esteem in which he was held by all sections of his countrymen. Representatives of the King and Queen, the Government, and municipalities were present, and the funeral procession passed through the streets of Haarlem along a special route, which was lined with people. Not only were the universities and scientific institutions of Holland strongly represented, but there were also representatives of foreign academies, including Prof. P. Langevin, Mme. Curie, Prof. A. Einstein, Prof. J. Verschaffelt, and Sir Ernest Rutherford, the latter representing the Royal Society of London. An eloquent eulogium on Professor Lorentz was delivered at the graveside by Professor Ehrenfest, successor of Professor Lorentz in the chair of theoretical physics in the University of Leyden, and was followed by short addresses by Sir Ernest Rutherford, Professor Langevin and Professor Einstein. In these speeches, emphasis was laid not only on the magnitude of his contributions to science both by his teaching and investigations, but also on his fine personality and character and the strong influence for good he had exerted in international scientific affairs. (*Nature,* February 18, 1928.)

Zodiacal Light Observations. — In response to the invitation published in POPULAR ASTRONOMY for January (1928) encouraging promises of coöperation in observing the Zodiacal Light have been received. Professor Leah B. Allen, director of the Williams Observatory, Hood College, Frederick, Maryland, and one of her students, Miss Eleanor Musser, have sent reports. From Mr. Oscar E. Monnig, Fort Worth, Texas, came an interesting report of an observation on January 14, together with photostatic copies of his sketches. An attempt to photograph the Light will probably be made by Dr. Chas. P. Olivier, University, Vir-

ginia. Miss Margaret Harwood, Nantucket, Massachusetts, and Princeton and Lick observatories have also expressed willingness to assist as opportunity offers. Persistent cloudy weather in this vicinity has interfered with consecutive observations but a comparison of the writer's observations in January, 1925, with observations made in January this year, indicates that the sunspot maximum makes no appreciable difference in the intensity of the Zodiacal Light which during January shows a brilliancy corresponding with the brighter parts of the galaxy in Cygnus. Discussion of reports received will be made in a later communication. More observers will be welcome.

W. E. GLANVILLE.

The Rectory, New Market, Maryland.

ϵ Aurigae. —A communication from the Washburn Observatory, Madison, Wisconsin, contains the following statement.

The long-period variable star ϵ Aurigae has been found by Stebbins and Huffer to have entered the eclipsing phase, apparently some months ahead of the prediction. Photo-electric observations on four nights from January 22 to March 4, 1928, show a progressive decrease in light amounting to 0.12 magnitude during the interval, and therefore the star is now changing at the rate of 0.08 magnitude per month. No previous measures were taken.

HARLOW SHAPLEY.

Harvard College Observatory Announcement Card 61, March 14, 1928.

International Astronomical Union. —The third session of the International Astronomical Union will convene at Leiden, Holland, on July 5, 1928, and continue until July 13. The first circular issued by the committee on local arrangements gives a list of the events of the week, aside from the regular meetings of the several committees which constitute the principal work of the session. The session will be opened at The Hague by representatives of the government and the delegates will be tendered a reception by the municipality of Leiden in the evening of the first day. Other features of the week will be: an excursion to the Lake District near Leiden; excursion to Haarlem, and an organ recital in the Cathedral there, on Sunday; excursion to the Zuiderzee reclaiming works; and a special dinner given by the local committee. Already between thirty and forty American astronomers, many of them with their families, have made definite plans to attend this session.

A meeting of the *Astronomische Gesellschaft* will be held in Heidelberg from July 18 to 21. Doubtless many of the visiting astronomers will avail themselves of the opportunity of attending this meeting also.

Nature-Guide School. — Announcement has just been made of a unique undertaking in education. The Senior Teachers College of Western Reserve University and the Cleveland School of Education are including in their summer session a school designed to train leaders in Nature study, in order to fill the calls which come from schools, scout troops, museums, and playgrounds. Very appropriately astronomy will be given a prominent place in such a school. The Observatory of the Western Reserve Academy, which claims the distinction of being the second oldest observatory in the United States, will be available for use. The school will be open from July 16 to July 28, under the direction of Dr. William G. Vinal, of the Cleveland School of Education, Cleveland, Ohio.

Forty New Variable Stars in Sagittarius.—*Harvard Bulletin* No. 855 contains an extension of the variable stars discovered at Harvard University from 4159 to 4199. These have been found on plates covering the star clouds in the Sagittarius region. Of these more than one-half appear to be of long period. The range in magnitude, in general, is from about the 13th to less than the 15th magnitude.

Junior Mathematician and Junior Astronomer. — An examination for the rank of Junior Mathematician for filling vacancies in the Coast and Geodetic Survey, and one for the rank of Junior Astronomer for filling vacancies in the Naval Observatory and the Nautical Almanac Office will be held in the near future. Those interested are requested to apply to the Civil Service Commission at Washington, D. C., not later than April 28. The date of the examination will be given when the application is accepted.

United States Naval Observatory Announcement. — The Civil Service Commission proposes shortly to conduct an examination to provide a register of applicants for the civil service grade of junior scientist (astronomer), the initial salary for which grade is $1860 per annum. The Naval Observatory has a present vacancy for a junior astronomer and a second prospective vacancy in July next.

The organization of the Naval Observatory and the manner in which its astronomical activities have been administered during recent years, with the continuing advice of a council of capable astronomers, provide as excellent an opportunity for scientific work as anywhere under Government auspices.

C. S. FREEMAN, Captain, U.S.N.,
February 28, 1928. *Superintendent.*

Graduate Courses in Astronomy at Harvard University. — Arrangements have been made by Harvard University and the Harvard College Observatory, beginning September, 1928, to give at the Observatory a new course for graduate students in Harvard and Radcliffe, entitled "Modern Astronomical Observations; Theory and Practice." The course will be composite in nature, the instructors and their subjects next year being as follows:

1. Visual Observations, Mr. Leon Campbell.
2. Photographic Observations, Professor E. S. King.
3. Spectrophotometry and Spectrum Analysis, Mr. H. H. Plaskett.
4. Classification of Spectra, Dr. Cecilia H. Payne.
5. Stellar Distances and Motions, Assistant Professor W. J. Luyten.
6. Clusters and Nebulae, Professor Harlow Shapley.

The course is intended to be a preparation for teaching, observatory work, or specialized research leading to a higher degree. The equipment of the Observatory will be available, as far as necessary, for students undertaking the work.

The course in theoretical astrophysics by Mr. H. H. Plaskett, who is now at Harvard as a lecturer in astrophysics, on leave from the Dominion Astrophysical Observatory, will be continued through the first semester of next year.

Arrangements have also been made with Harvard University for research courses at the Observatory under the direction of Professor Shapley on stellar systems, Mr. Plaskett on astrophysics, Dr. Luyten on stellar statistics, and Dr. Fisher on the problems of meteors.

BOOK REVIEWS.

Beyond the Milky Way is the title of a book published by Charles Scribners Sons in 1926. The author is Professor George Ellery Hale, honorary director of the Mount Wilson Observatory. Having said this it is unnecessary to say anything further in commendation of the book. It consists of three chapters: The Oriental Ancestry of the Telescope; Heat from the Stars; Beyond the Milky Way. In consideration of the fact that only a few years ago the "Milky Way" was regarded as all-inclusive, the title at once arrests attention. Anyone who aspires to be up-to-date in astronomy is strongly advised to read this brief, interesting, and authoritative account of the recent developments in this science.

Starlight.—This title of a book by Professor Harlow Shapley, director of the Harvard College Observatory, is happily chosen. The book bears out very well both the literal and figurative interpretation of the word. The light which comes to us from the stars leads to a great amount of information concerning these distant bodies. The recent discoveries are admirably set forth in this small volume. In a figurative sense, the author, by his clear and comprehensive grasp of facts, by his vivid and interesting style, and by his careful and intelligent sifting out of the most important items from an enormous literature, has thrown much light on the stars. Anyone with an average education and a fair imagination can glean in a few hours from this book accurate, interesting, and stimulating information. He will feel his mental horizon widening in keeping with the widening horizon of space.

Stellar Radial Velocities, by W. W. Campbell with the collaboration of J. H. Moore. *Publications of the Lick Observatory*, Vol. XVI. (University of California Press, Berkeley, 1928. Pp. XLV + 400.)

Eighty years ago Fizeau for the first time expressed the belief that the motions of celestial bodies, in the line of sight, could be determined from displacements of spectral lines. Forty years later the first reliable measurements were made almost simultaneously at Potsdam by Vogel and Scheiner and by Keeler at the Lick Observatory. Another period of forty years has brought about the completion of the first systematic survey of radial velocities ever attempted.

Volume XVI of the *Publications of the Lick Observatory* embodies the results of more than 30 years of observations, started and carried through by Dr. W. W. Campbell with the able coöperation of Dr. J. H. Moore and with the assistance of several scores of other astronomers who at one time or another participated in this enormous undertaking. The catalogue contains the radial velocities of nearly all stars brighter than visual magnitude 5.51 over the whole sky, 2771 in number. The remaining 69 stars, listed at the end of the book, have all been investigated at other observatories, so that our knowledge concerning the motions of the brighter stars, other than binaries, is now fairly complete. The number of spectrograms used is approximately 25,000. Of these about 15,000 were secured at Mount Hamilton and 10,000 at Santiago. Many plates have been measured twice or even three times—by different persons—and the total number of separate measures must be close to 35,000.

The value of this work will be obvious to everyone. However, special atten-

tion may be directed to a few points which seem to me especially interesting.

Perhaps the greatest immediate value of the book is of a *statistical* nature. This has been recognized by the Lick astronomers, who have utilized their material for a new determination of the motion of the solar system (Introduction, pages 32-39), and for the derivation of the mysterious K-term indicating the prevalence of positive velocities over negative ones. Thus for the B-stars a value of $K = +4.9$ km/sec is found showing that the average of all velocities for the 284 stars used is not zero, as would be expected, but that a positive residual is obtained. The exact interpretation of this term is a task for the future. Doubtless, statistical astronomers will utilize this catalogue for numerous other investigations.

The Lick observations of radial velocities give for many stars almost continuous record for the past *thirty years*. Astronomical changes come about so slowly that the life-time of one observer is often insufficient to record one complete process. Such determinations as those from the Lick Observatory retain their value almost indefinitely. Slow variations in velocity, such as may be expected in certain double stars, will doubtless be revealed in a good number of stars. Astronomers interested in spectroscopic binaries will find among the Lick observations much valuable material for improving and checking their orbits.

The appearance of the Lick volume definitely places work on stellar radial velocities among the *exact sciences*. It is perhaps not sufficiently realized among astronomers in general that measurements of radial velocity as well as methods of reduction are quite as rigorous as those used in the most refined meridian observations. The instrument is probably even more delicate than the best meridian circle. This is brought out in the Introduction dealing with the instrumental equipment (pages 3-17) and again in the chapters on systematic corrections (pages 21-30) and on the comparison with other observatories (pages 30-32). As a matter of fact, the quantities to be measured are frequently of the order of 0.001 mm, and the probable error of one final velocity from a single plate corresponds to something like 0.0003 mm. These quantities are of the same order as those measured in the most refined parallax observations.

It is especially gratifying to find a complete discussion of *systematic errors*. It is a striking fact that our experiences at the Yerkes Observatory have in many respects been similar to those of the Lick observers. The most puzzling systematic error is probably the one depending on flexure. This is not due, as might be inferred from the name, to differential flexure of the spectrograph itself. It arises from the bending of the telescope tube causing defective collimation of the spectrograph; the beam of light from the telescope objective falls eccentrically on the collimator lens. The question arises: why does improper collimation cause erroneous radial velocities? The Lick observers suggest that this may be due to possible non-homogeneity of the optical parts (Jacobsen) although the effect also depends on the width of the slit. They have derived empirical corrections to allow for this error since 1920. A similar systematic effect has been found at the Yerkes Observatory. Here it is also a matter of improper collimation combined with small errors in the focus of the spectrograph camera. If the collimation is faulty the light from the star forms an eccentrically illuminated disc on the collimator lens, consequently the path of light from the star differs from that of the comparison spark. If, then, the focus is not correct (or if the glass in the prisms is not homogeneous) there will appear on the plates a spurious displacement of the stellar lines. In some cases the error thus introduced may amount to 1 km/sec

for a change in focus of a 24-inch camera of only 0.1 mm. I have found that by placing the plate 1 mm inside or outside the true focus the spectrum of the sky may be made to give velocities of approach or recession amounting to 10 km/sec. The remedy consists in accurately collimating the instrument and in focusing the camera by a precise method, such as that devised by Professor Newall.

These experiences will suffice to show that a stellar spectrograph is an extremely delicate instrument, and that the greatest care must be exercised in its adjustment and operation. Professors Campbell and Moore have admirably succeeded in giving us a *system of radial velocities practically free from systematic errors.*

OTTO STRUVE.

Yerkes Observatory.

Atlas of Selected Regions of the Milky Way, by E. E. Barnard. (Carnegie Institution of Washington, 1927. $10.00.)

The long awaited publication of this work has finally been achieved. It was prepared for publication by Professor Frost and Miss Mary R. Calvert.

The work is in two volumes. The first volume contains a portrait of Professor Barnard, an introduction by Professor Barnard which includes a description of the 10-inch Bruce telescope with which the Milky Way photographs were taken, a catalog of 349 dark objects in the sky, and 51 plates of the Milky Way with brief descriptions of each. The plates are photographic prints from second negatives and are about 9.5 inches square.

The second volume contains specially drawn charts for each plate on the same scale with right ascension and declination indicated along the borders, the principal stars marked and special objects noted. On the page opposite each chart are the B.D. number of the principal stars, their coördinates for 1875, their H.D. magnitude, and spectral class.

The immense amount of labor required to prepare this work for distribution deserves special mention. The preparation of second negatives to give proper printing density was the first step. The actual printing from these negatives was done by a commercial photographer but everyone of the 35,000 prints for this edition of 700 copies was personally inspected and passed upon by Professor Barnard. Many prints were rejected and others made to replace them before he was satisfied. Each print is mounted on cloth.

The charts of the second volume were drawn by Miss Calvert. The notes and descriptions were for the most part written by Professor Barnard but they were sorted out and arranged by Miss Calvert who had been Professor Barnard's assistant for some years. It is difficult to estimate the total time required but these two volumes must represent at least ten years' work for one individual.

These wonderful photographs of the Milky Way must be seen to be appreciated. The decision to have photographic reproductions of the plates instead of half-tone engravings is fully justified. They set a new standard for the publication of astronomical photographs and are a fitting memorial to one of America's greatest observers. E.A.F.